SEPTEMBER 1956

# PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

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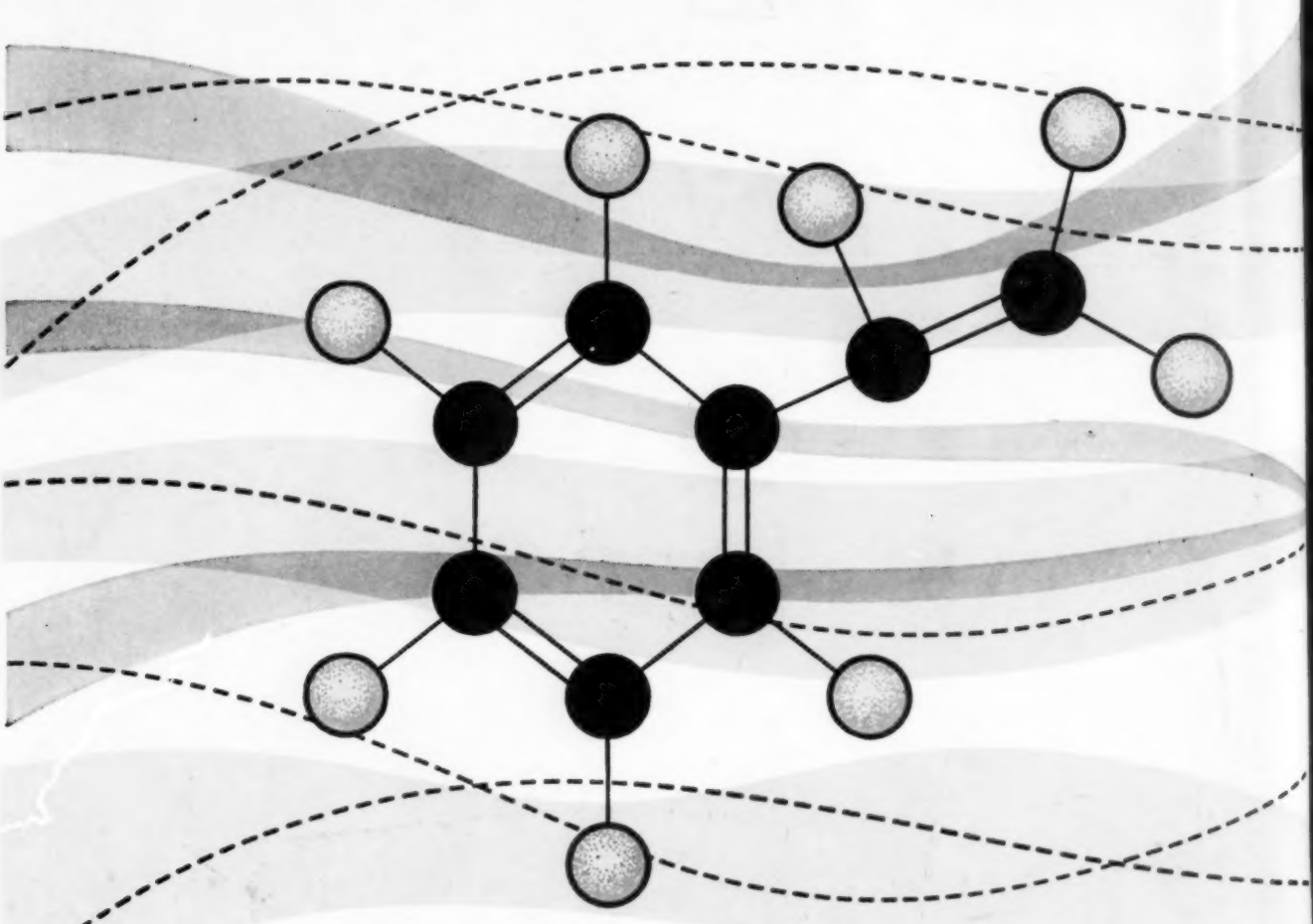

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THE MAGAZINE OF APPLIED ENGINEERING

# PLASTICS TECHNOLOGY

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# "Quote . . . Unquote"

## *Chemical Industry Computers*

"The electronic computer is a relatively new and amazing expediter of progress. One of its uses is in research. By translating known data into mathematical equations which are fed into this machine, the chemist frequently can determine which experiments are likely to be productive before he enters the laboratory. The results also guide him away from experiments which would be useless to try, saving months of trial-and-error work.

"Similarly, the computer has been used to increase production. In a chemical process at our plant in Victoria, Tex., involving the making of a polymer intermediate, it was decided to feed into a computer a large number of variables of temperature, concentration, pressure, and rate of flow through the equipment. The result made it possible to change operation conditions so as to obtain a 25% increase in product.

"It is suggested that large computers can be used in place of pilot or semi-works in the development of some chemical processes from the lab to the production line.

"Computers are also proving useful in color-matching plastics. It takes a skilled colorist by conventional methods an average of three days of trial-and-error to arrive visually at a correct color formulation for a batch of plastic resin to match an order. By feeding mathematical data, including such variables as concentration of dyes, light absorption, and wave lengths, to a large-scale electronic digital computer, it is possible to come up with proper color formulas within five minutes."

*Samuel Lenher, Vice President,*
*E. I. du Pont de Nemours & Co.,*
*Wilmington, Del.*

• • •

## *Chemical Industry Research*

Quote . . . Unquote is moved from page 617.

"The chemical industry's research expenditure represents a greater proportion of its sales dollar than is the case in any other industry. It employs more scientists in research than any other industry.

"If research is to be regarded as an instrument of sound progress rather than as a routine process attendant upon changes in economic climate, it is essential that the budget provide funds for this type of work and that management defend its aims.

"Research directors must maintain standards and exact such performance that they can exert an influence equal to that of other departments which are represented in the planning councils of the company.

"Beyond the exploratory stage, the research task force should have the advice of sales and production representatives."

*J. J. Healy, Jr., Asst. to the Vice Pres.*
*in charge of Research,*
*Development and Engineering*
*Monsanto Chemical Co., St. Louis, Mo.*

# Letters to the Editor

### Questions Editorial Implication

Dear Sir:

The editorial "Sharing Industry Responsibilities" was certainly interesting, but perhaps not timely. Had it been printed before the promulgation of the "Statement of Principles of the Plastics Industry," it could have been the springboard for this important document.

It is my understanding that the major firms in the plastics industry have signed and are following the principles outlined. Hence, your editorial must be directed to a small minority who apparently are not acquainted with this creed.

Those who subscribed to the Principles, whether material suppliers or fabricators, cannot and do not ignore their responsibilities. This concept does not prevent the material supplier from presenting his product in a "favorable light," but does not permit him to "ignore his responsibilities."

It is true that "plastics have gained a damaging reputation as cheap and inferior items," but this has occurred in spite of the heroic efforts of the reputable suppliers and fabricators. I have personally campaigned against such abuses, and have never known your remarks to be applicable to a firm which has subscribed to the Statement of Principles.

I can assure you that our firm and most of the other suppliers and fabricators are not "acting like irresponsible juveniles." They became adults years ago.

Today, there exists a small percentage of children and adolescents in all industries. It is the responsibility of the leaders in these industries to educate these individuals so that they may become responsible adults. Few are doing a better job of educating the plastics industry than the SPI, MCA, and SPE.

I suggest that PLASTICS TECHNOLOGY publicize and support these activities.

*Raymond B. Seymour, Pres.*
*Loven Chemical of Calif.*
*Newhall, Calif.*

*(Our editorial was based on both direct observation and opinions expressed by our readers. To date, this is the only dissenting letter received since the editorial in question appeared. For further comments, see this month's editori page 575).*

• • •

### Likes Editorial

Dear Sir:

This is in reference to your editori on "Sharing Industrial Responsibiliti (April, May, June).

You have completely expressed m thoughts in this matter, and I want compliment you for the fine stand th you have taken. I hope the editori will do some good.

*Edward Singer, President*
*Victory Manufacturing C*
*Chicago, Ill.*

• • •

### Agrees with Editorials on Improvi the Plastics Exposition

Dear Sir:

I have been reading with interest yo editorials on improving the Plastics E position (July, August 1956).

As far as we here at Loma are co cerned, this show should be basically trade show for those of us in the plasti "converting" business.

It was rather discouraging for o people who were at the show to have wait in line to see machinery, mater supplies, and other exhibits of inter which were jammed with tourists.

I doubt very much if we will want attend another show where it is abs lutely impossible to see anything from technical standpoint, and where a people you want to see must be se after or before the show hours.

If there is to be a distinct demarcati between a trade show, as is genera held in various industries, and a marke ing show, I believe two separate sho should be held, for the way they a currently set up confuses both functio

I realize that our industry is movi so fast and so furiously that oftentim it is difficult to evolve the proper fo mula for a successful show. Howeve we feel that if it were to be a trade sho it should be only a trade show wi registration strictly limited to tra people.

I agree with your suggestion that th exposition should be open to the publ for one day or a limited time each da

to let people see the great new "wonderful things being done in plastic."

From what they tell me, there was much to see at the recent show. I regret that in five days I was only able to see perhaps one-third of what I should have seen. I hope the situation will be remedied by the next show. Certainly we have the manpower and capable organization who should be able to evolve a better plastics exposition. I, for one, look forward to it.

*Louis H. Barnett, President*
*Loma Plastics, Inc.*
*Fort Worth, Texas*

• • •

**Ice Scrapers Wanted**

Dear Sir:

We are trying to locate the manufacturers of an inexpensive plastic automobile window ice scraper.

We plan to use this item for an inexpensive advertising specialty, and would appreciate your supplying us with names of companies which presently manufacture such items.

*Harry N. Wessel, Jr*
*Merlite Industries*
*New York, N. Y.*

*(A list of manufacturers of plastic ice scrapers for auto windows has been sent to the inquirer. This letter is being printed to elicit further sources of supply.—Editor)*

• • •

**Wants Foam Rubber Coating**

Dear Sir:

We are searching for a plastic that can be sprayed, dipped, or painted on natural foam rubber to form a waterproof surface. Cure of such a coating must be either chemically at room temperatures, or in dry heat at temperatures not exceeding 220° F.

Can you direct us to a supplier?

*(Identity Withheld)*

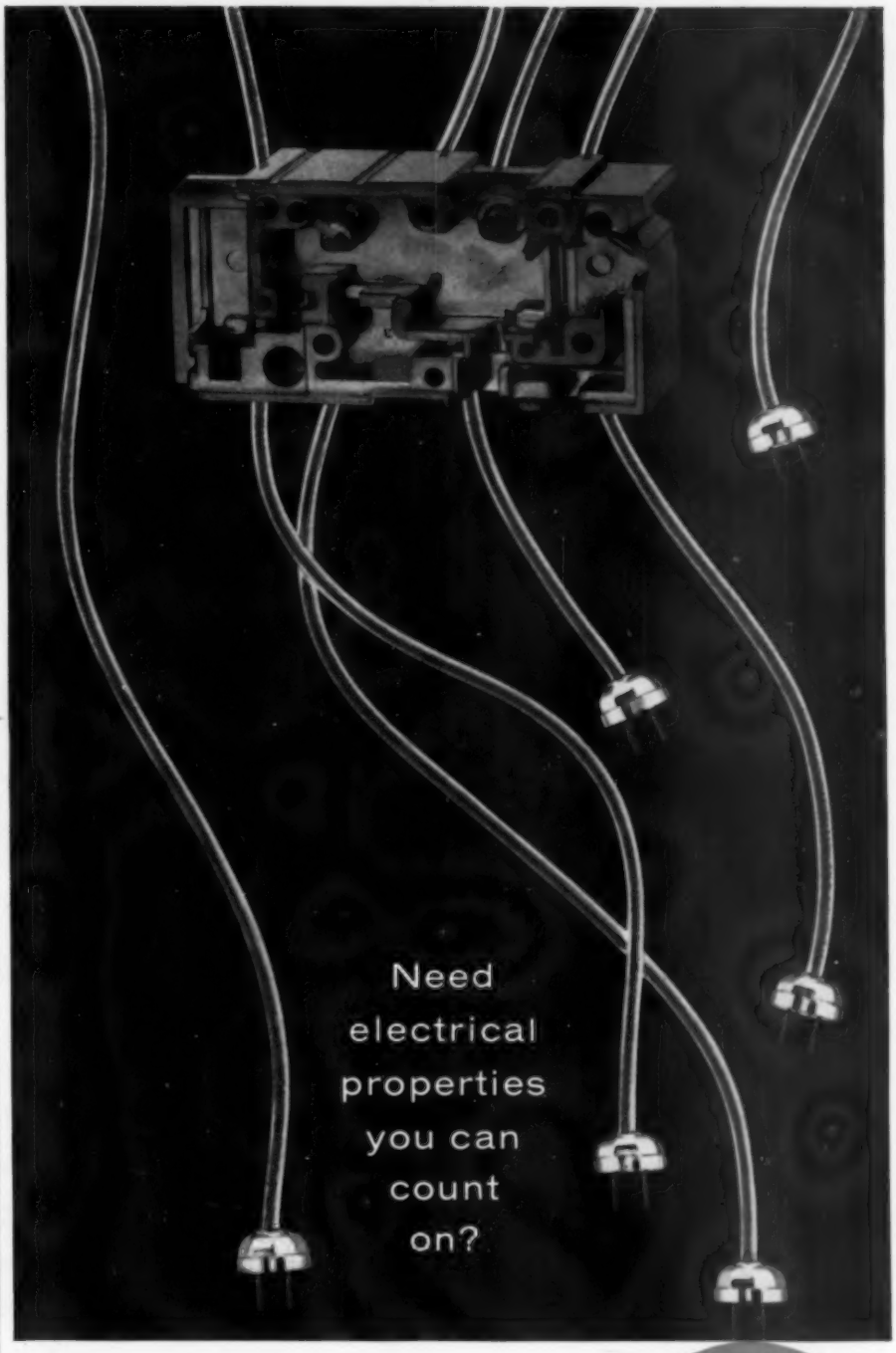
*(Suggestions are invited for transmittal to the inquirer.—Editor)*

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

A letter will not be printed if publication is not desired by the sender.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request the identities of such "problem" letters will not be divulged.

—The Editor

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# NEWS in BRIEF

Credit for plastics companies being turned down on bank financing can be obtained under a plan worked out by Standard Factors Corp. in cooperation with commercial finance companies, according to T. H. Silbert, president of SFC (see guest editorial, pages 589-90). Available to going businesses having a reasonable outlook for growth and expansion, the plan provides confidential, long-term loans with 3-5 year maturities.

Company developments in the plastics industry include the signing of a non-exclusive epoxy resin patent license agreement for the U. S. and Canada by Ciba. Ltd., of Switzerland, and Devoe & Raynolds. As a joint project, I.C.I., of London, and Hercules Powder will build an $11-million Perspex plant in Louisiana, Mo., with an annual capacity of 34-million pounds of methyl methacrylate monomers and polymers.

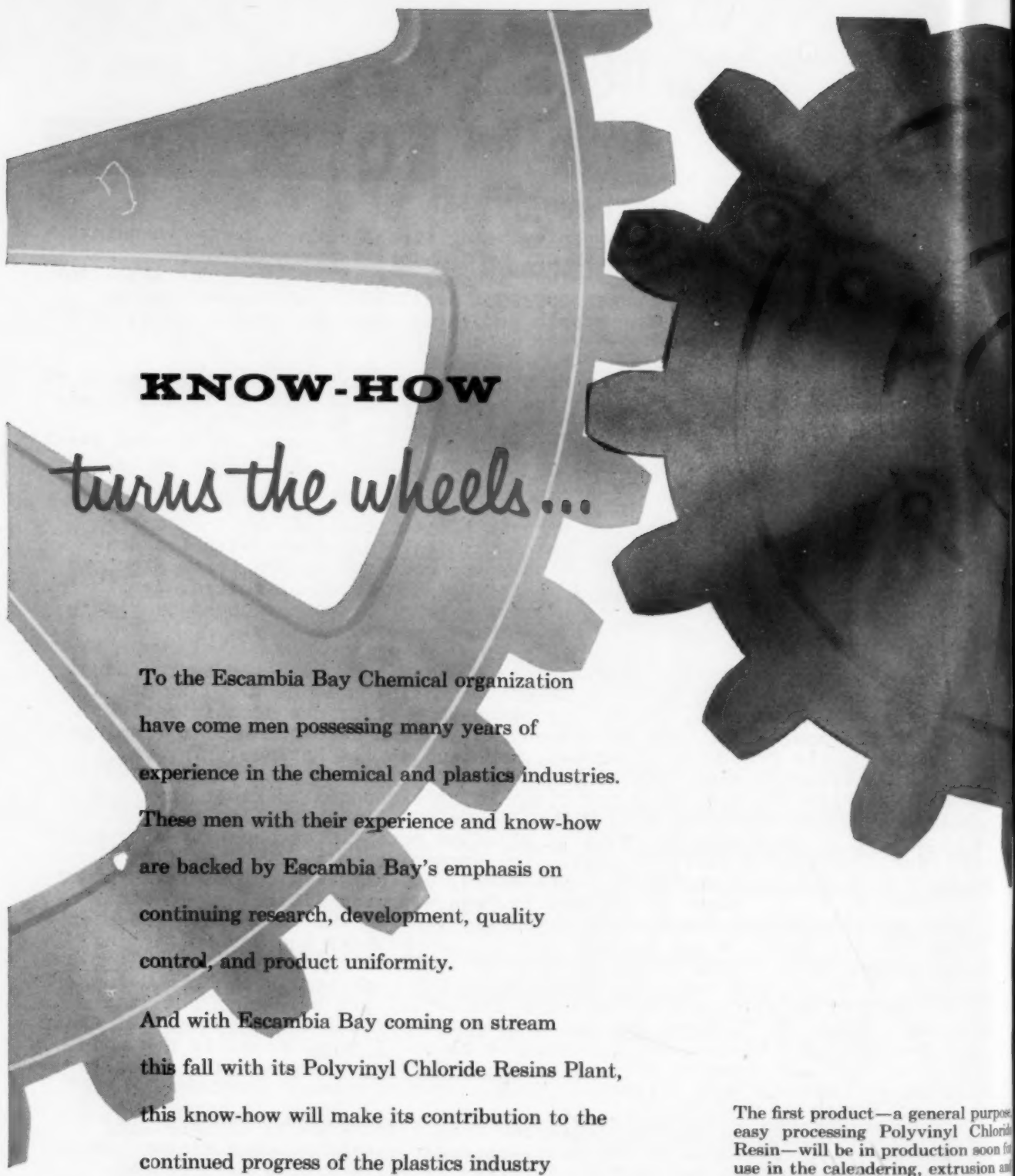
Three changes in company ownerships occurred last month. Borden acquired the holdings of Pioneer Latex & Chemical for merger with its Resinous-Reslac department. Vinyl plastisols and coatings manufacturer Michigan Chrome & Chemical purchased Pyramid Plastics, industrial extruders. Zenith Plastics, makers of plastic components for aircraft, was purchased by Minnesota Mining & Mfg. for operation as a wholly-owned subsidiary.

Company expansions in plastics have not been hampered by the usual summer let-down. Dominion Rubber's Naugatuck division is quadrupling its lab space at the Elmira, Ont., plant. Dow plans to build a new administrative center in Midland, Mich., and has formed an Eastern Research Lab at Framingham, Mass. Durite Products, of Borden, has doubled its Philadelphia, Pa., plant facilities. An expansion is in progress at Famco's plant in Louisville, Ky. General Tire has announced the first major expansion in floor covering production at its Jeanette, Pa., plant. Gomar Mfg. is completing a new plant in Linden, N.J. Interchemical's resin plant in Bauer, Utah, destroyed by fire last year, has been rebuilt to double the former capacity. Lustro Tile Products will build an addition to its Akron, O., plant. A major expansion of its Anderson, S. C., plant is planned by Owens-Corning Fiberglas. In its fourth expansion since the war, Pacific Plasti-Fab moved to an enlarged plant in San Carlos, Calif. A new factory for radiant heaters and vacuum forming equipment has been set up by Ned L. Roberts in North Hollywood, Calif. Shell Chemical is building a two-story addition to its tech service lab in Union, N. J. Standard Insulation will increase its office and warehouse facilities in East Rutherford, N. J. Texas Co. and U.S. Rubber will increase output of their jointly-owned Port Neches, Tex., butadiene plant. Thermel moved to new and larger quarters in Franklin Park, Ill. Union Carbide has announced plans for building on its site near Tarrytown, N. Y.

New Materials worthy of mention (see pages 610-1): high-boiling lacquer solvent; barium-zinc soap stabilizer for vinyl; monomer dispersant for vinyl plastisol resins; two synthetic waxes; methyl silicone mold release emulsion; two azo red toners; series of phenolic foundry resins; and hydroxyethyl cellulose thixotropic agent for latex paints.

New Equipment in the news this month (see pages 612-3): series of high-efficiency extruders; pneumatic machine tool; compensating weigh feeder for injection machines; automatic cut-off saw for rigid extrusions; and leveling and splitting machine for foam slab stocks.

New Products of special interest (see pages 614-5): self-adhesive decorations; paper capacitors with molded alkyd shells and polyester wire seals; molded valve units of modified styrene; fluorocarbon-faced ball joints; vinyl impregnated patching material; fluorocarbon aircraft hose assemblies; molded polyethylene caps for dry cell batteries; vacuum bags for reinforced plastics molding; Mylar dielectric capacitors; and molded urea and phenolic closures.



# KNOW-HOW

## turns the wheels...

To the Escambia Bay Chemical organization have come men possessing many years of experience in the chemical and plastics industries. These men with their experience and know-how are backed by Escambia Bay's emphasis on continuing research, development, quality control, and product uniformity.

And with Escambia Bay coming on stream this fall with its Polyvinyl Chloride Resins Plant, this know-how will make its contribution to the continued progress of the plastics industry through intensive technical and customer service programs.

The first product—a general purpose easy processing Polyvinyl Chloride Resin—will be in production soon for use in the calendering, extrusion and molding industries. Following this Escambia Bay will produce a molecular weight range of straight PVC Resins including types for electrical and rigid applications.

**ESCAMBIA BAY CHEMICAL CORPORATION**

261 MADISON AVENUE • NEW YORK 16, N.Y.

PLASTICS TECHNOLOGY

SEPTEMBER, 1956

# EDITORIAL: Hastening Industry Maturity

In the editorial series "Sharing Industry Responsibilities" which appeared in our April-June issues, we pointed out that the materials suppliers and the plastics processors, the two major segments of the plastics industry, have been quite successful in ignoring or even flouting their responsibilities to themselves, to each other, and to the consumers.

At the same time, we noted that plastics have made steady gains in industrial applications where both groups have met their responsibilities under the watchful eye of the industrial user. In conclusion, the editorial urged that both groups come of age and voluntarily discharge their responsibilities.

•

We have received many letters of comment from materials supplier and plastics processing companies since the appearance of the editorial. Some of these letters have been printed in the "Letters to the Editor" columns of this and the July issues. From the standpoint of industry maturation, it is gratifying to note that most of these letters have freely admitted the truth of our statements and the value of periodic, continuing reminders of the industry's need for cooperation and mutual responsibility.

In the Letters column of this issue, we have printed the only letter received to date which questions the implications of our editorial. The writer states that our editorial is out of date, since the evil practices described have been outgrown to a major extent since the promulgation of the "Statement of Principles of the Plastics Industry." He insists that he has never known our remarks to be applicable to a firm which has subscribed to the aforementioned Principles.

We agree that a company adhering rigidly to the Principles could not be guilty of the evils of omission and commission inveighed against in our editorial. The obvious questions are: How many plastics companies have signed the Statement? Of these, how many really adhere to the Principles? Frankly, we would not care to answer these questions; the answers would be somewhat embarrassing to the industry.

•

With some of the plastics "junk" and actual misapplications currently on the market, it is obvious that adherence to the Principles is still far from universal throughout the industry. For proof, ask any housewife what she thinks of some current plastics items!

We have conducted an informal survey of household consumers of plastics asking what they thought of the Principles. Everyone heartily approved of them, but all were amazed to learn that the original Statement had been promulgated two years ago.

This, of course, only bears out the contention of our editorial. It is true that the plastics industry has come a long way towards adulthood with its attendant obligations and responsibilities. Let us help the growth continue to complete fulfillment!

Arthur M. Merrill

Editor

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# Effect of Molding Technique on The Long-Time Heat Resistance Of Phenolic Laminates*

**Vacuum bag, high-pressure, and low-pressure cures affect laminate porosity and elevated-temperature strength**

J. D. FLYNT, *Supervisor, Experimental Fabrication & Development Dept.*

*Cincinnati Testing & Research Laboratories,*

*Cincinnati, Ohio*

PHENOL-FORMALDEHYDE resins, although they represent the earliest efforts in what is now the reinforced plastics industry, had become virtually "forgotten children" in recent years. Perhaps it was because they did not represent a recently developed polymer group that phenolics were given a back seat. There probably existed in the minds of plastics engineers an attitude that everything possible was known about phenolics, with no further exploration needed.

Examples can be cited to illustrate the attitude toward phenolics on the part of people concerned with high strength and heat-resistant laminates. For a number of years, a great deal of time and money have been expended in attempting to improve the bonding of synthetic resins to glass fibers through the application of various chemical finishes and heat-cleaning processes. Despite this, there is today only one commercially available glass finish, NOL-24, formulated specifically for phenolics. This finish is less than two years old, and its commercial availability is more a matter of technical reference than actual fact at the time of this writing.

It is true that there are other glass finishes which work quite well in conjunction with phenolics. However, they were formulated basically to aid the bond of some other polymer group, and the fact that they do work with phenolics is merely incidental and often lightly referred

* Based on a paper presented before the reinforced plastics division, Society of the Plastics Industry, Inc., Atlantic City, N.J., Feb. 9, 1956.

Jerome D. Flynt was born in Cincinnati, O., and attended the University of Cincinnati, receiving a B. S. in Marketing in 1950. Since that time, he has been taking graduate work in mechanical and chemical engineering at the same university. He joined Cincinnati Testing & Research Laboratories in 1950, serving 1½ years as laboratory technician; three years as project engineer on phenolic resin research, aircraft part development, and production of phenolic materiels; and 1½ years as general laboratory supervisor. He has held his current position since early this year. Mr. Flynt resides in Cincinnati with his wife and two children.

to in the technical literature on these finishes.

A second example which might be cited is the fact that those parts of the military establishment concerned with structural laminates have had a specification (MIL-R-9299) covering phenolic resins for only a little more than a year. They had, of course, a specification (MIL-R-7575) covering laminating resins in general for quite some time, but any resin which qualified under that specification had to act, look, and mold like a polyester before it had the least chance of being accepted. It is to the credit of the people responsible for such specifications that they overhauled their system so that other polymer groupings can now qualify for military use under more appropriate specifications.

The revived interest in phenolics for structural applications is due, at least in part, to the almost unbelievable advances which have been made in the various segments of the aircraft industry. Designers have moved so fast, that builders have begun to cast around for new materials from which to make their aircraft, engines, missiles, etc. Steels are too heavy, magnesium alloys too corrosive, aluminum loses strength too rapidly under high-temperature exposure, and titanium has not lived up to its advanced billing as a universal panacea for all ills of the aircraft builder.

The aircraft industry needs materials which have high strength, especially when compared to aircraft metals on an equal-mass basis. It needs materials which can maintain their integrity and a sizable portion of their strength under exposure to temperatures in the range of 400-500° F. and higher for periods as long as 200 hours. It needs materials which will permit the manufacture of parts at low unit price under production conditions. Reinforced phenolic laminates provide at least one answer to their quest. Aircraft men are not unfamiliar with phenolics, having long employed them for various thermal insulating jobs (chiefly moderate-temperature ducting for cabin heating, de-icing, etc.). They also have investigated phenolics for more extensive structural applications as possible replacements for metals.

The recent turns which aircraft design have taken have changed the outlook of aircraft men toward phenolic laminates. Where they once looked on phenolics chiefly through critical materials curiosity, they are now in earnest about developing phenolic structural parts for immediate use. The development of new and better phenolic and modified phenolic resins, new glass finishes, and improved reinforcing materials has contributed greatly to placing phenolics in their present favorable position.

To meet the challenge of the aircraft industry, phenolic processors must get the most from their materials. The curing methods they employ must provide high mechanical properties (particularly modulus of elasticity), good long time (200 hours and more) heat resistance, and smooth aerodynamic surfaces. Almost invariably, parts must be held to extremely close dimensional tolerances, and occasional structural flaws (especially the type which cannot be found readily by inspection) must be eliminated. The cost of the parts involved must be feasible if made on a high or moderate production basis.

While all the factors alluded to above will be given some consideration in their relationship to molding techniques, it is the purpose of this paper to discuss such techniques mainly as they relate to long-time heat resistance and mechanical properties. It is virtually impossible to consider these two factors independently since they have a definite and inseparable inter-relationship, except in cases of pure thermal insulation.

## Curing Techniques

Two basic curing techniques for phenolic laminates, and many variations thereof, have been employed for years throughout the industry, and are still used for most phenolic laminating. The first, the vacuum cure, is sometimes used with augmentation from an autoclave. Since most commonly-used bagging materials have definite temperature limitations, it is often followed by a short post-cure to bring the formed laminate to temperatures which were not possible while it was bagged. The other method involves a one-shot press cure usually accomplished somewhere between 300-350° F., with the temperature raised in intervals as a flow control. If a post-cure is used, it is probably to realize economies from reduced press time.

### Vacuum Bag Cure

Let us examine the vacuum bag-type cure in terms of long-time heat resistance. Since phenolics cure by condensation, there is always a certain amount of volatile

Table 1. Effect of Heat Exposure on Phenolic Laminates Made with 181-114 Glass.

| Cure Type | Laminate Thickness, in. | Property | Room Temp. | After Exposure to 400° F. for ½-Hour | After Exposure to 400° F. for 100 Hrs. | After Exposure to 400° F. for 200 Hrs. | After Exposure to 500° F. for ½-Hour | After Exposure to 500° F. for 100 Hrs. | After Exposure to 500° F. for 200 Hrs |
|---|---|---|---|---|---|---|---|---|---|
| Vacuum | ⅛ | Ult. flexural strength, psi. | 55,000 | 47,500 | 41,150 | 32,800 | 44,900 | 10,500 | 8,000 |
| | | Weight loss, % of total | — | — | 0.5 | 1.0 | — | 10.5 | 14.8 |
| | | Modulus of elasticity, psi. x $10^6$ | 3.25 | 3.00 | 2.85 | 2.60 | 2.90 | <1.00 | <1.00 |
| | ½ | Ult. flexural strength, psi. | 48,900 | 39,300 | 28,500 | 15,000 | 38,500 | 4,400 | 2,600 |
| | | Weight loss, % of total | — | — | 0.8 | 1.4 | — | 12.8 | 15.5 |
| Low Temp. | ⅛ | Ult. flexural strength psi. | 54,000 | 45,000 | 43,500 | 44,000 | 44,000 | 35,000 | 20,000 |
| | | Modulus of elasticity, psi. x $10^6$ | 4.32 | 3.80 | 4.05 | 4.07 | 3.65 | 2.60 | 2.00 |

matter which must be exuded during the cure. Polyester resins do not present this problem, since they generally consist of 100% polymerizable solids which cure by addition rather than condensation. In simple terms, polyester molecules form chains and cross-link by hooking together, while phenolic molecules must release atoms of hydrogen and oxygen which go off as water.

In a pre-impregnated or "B-stage" phenolic laminating material, these volatiles will amount to 1½-3% of the total weight of the material (in terms of the resin present, they would amount to 2-3 times that percentage). There also are other volatiles present in the form of solvents, unreacted phenol or formaldehyde, and released catalyst. The handling of this volatile fraction is the focal point about which almost all phenolic laminating techniques are built.

The vacuum bag technique handles the phenolic volatile fraction in two ways: (1) the vacuum itself tends to draw off the volatiles while the heated resin is still in a liquid state; and (2) the low laminating pressures permit the volatiles to "take care of themselves" by forming a network of pores through which they can escape as they are released. Vacuum pressures are sufficiently low that the pressure exerted by the products of condensation as they are released from the phenolic molecules and expand into gases can overcome the vacuum pressures and allow the gases to form their own routes of escape. This network of voids or pores becomes set in the laminate once the thermosetting action takes place.

There are various techniques employed to reduce voids to a bare minimum, such as frequent "rub-outs" and breathing (momentary release of pressure). These operations can certainly reduce the amount of porosity in a laminate; however, since molecular linkage and the resulting release of the volatile products of this linkage continues up to and past the point where the resin becomes completely set, it is totally impossible to eliminate porosity entirely. Indeed, it would be undesirable in a low-pressure laminate for the network of pores to disappear entirely, since it forms an escape route for those volatiles released after the final setting takes place. If such a means of escape is not provided, a low-pressure phenolic laminate can be damaged by released volatiles before the cure is completed. As the resin is setting, entrapped volatiles will sometimes cause the laminate to take on a "picture frame" appearance in which the center of the laminate is much lighter in color than the edges. In extreme cases, the surface of the center portion may be roughened by the violent release of the volatiles.

When the surface has not been roughened, a "picture frame" type laminate might seem to be serviceable in cases where appearance is unimportant; in fact, the room-temperature properties are often nearly as good as those of an undamaged laminate. The elevated temperature properties, however, suffer considerably. The "framed" areas will exhibit short-time elevated temperature properties that are far below normal, and these areas will deteriorate rapidly under prolonged exposure to heat.

Since the porous condition of the vacuum-type phenolic laminate cannot be avoided, the long-time heat resistance of such laminates must presuppose some porosity. Since this porosity is formed through the action of active volatiles released by curing resin, one must assume that the porosity will take the form of a network rather than isolated bubbles similar to the type formed in polyester through air or moisture entrapment.

Phenolics will inevitably be subjected to oxidation after prolonged exposures at temperatures of 400° F. and above. This is true regardless of how heat-resistant the particular formulation might be. A series of pores, therefore, presents an extremely large surface over which oxidation can proceed. This is often true to such an extent that the deterioration of a vacuum-type laminate under heat exposure appears to be, and actually is, a simultaneous degeneration of the entire cross-section of the structure. Thus, the laminate as a whole is seldom able to outlive the oxidation of its surface. The deterioration of vacuum-type phenolic laminates under heat exposure, as reflected by declining mechanical properties and loss of weight, is shown in Table 1.

The initial ultimate tensile, compressive, and flexural

properties of vacuum-type phenolics are usually as high or, in some cases, slightly higher than their counterparts made using other fabrication methods. However, other mechanical properties do not show up as well; tangential and offset limits or, more simply, the stress levels at which they become permanently deformed, are quite low, and the all-important modulus of elasticity also is low.

Unfortunately for laminators, the properties which do not show well on vacuum laminates are those in which aircraft designers are most keenly interested. They do not care that a particular type of phenolic laminate has an ultimate flexural strength of 80,000-90,000 psi., if they find that isolated fibers will begin to rupture at 40,000-45,000 psi. If they find that it has a low modulus of elasticity, they will not bother to look for anything else. Prolonged heat exposure rapidly reduces all properties so that they soon cease to have any suitability for aircraft applications. Responsibility for the lowness of most of the vacuum laminate's mechanical properties can, again, be laid on its porosity.

The vacuum laminate does not grade highly on some of the other points in which aircraft men are most concerned. Close aircraft dimensional tolerances are difficult to hold, causing high rejection rates. On complex-shaped parts, the vacuum can sometimes become sealed off from isolated areas. This could result in a structurally weakened area which might not be visually apparent, and which could be of such a shape that it defies dimensional measurement. In such a case, it would probably go into service undetected. From a production standpoint, the vacuum process is cheap for large cumbersome parts, and for parts of any size when a small number of pieces is desired. In full production, however, vacuum operations become quite expensive because of the large amount of labor involved.

### High-Temperature Press Cure

The second type of cure which is used commonly in phenolic laminating, the high-temperature press cure, does not lend itself to generalizations as readily as the vacuum-type cure. The reasons for this are the vast combinations of temperatures and pressures which may be employed, and such laminating tricks as periodic breathing, incremented temperature increases, etc. The laminates produced cannot be placed in a single category, but can, however, be classified to some extent if subdivided into high and low pressure groups. For purposes of brevity, the low-pressure group (up to 50 psi.) can be said to act generally in the same manner as the vacuum-type laminates. There are some differences, but they don't tend to greatly alter the resulting laminate.

Most of the differences lie in the relative advantages or disadvantages in actual molding which one method might hold over the other. For instance, the low-pressure press cure is cheaper, unless expensive tools are involved, and permits better time and temperature controls. On the other hand, the size of laminate is more restricted with the low-pressure press cure. Without the vacuum to help draw off the volatile matter, gases near the center will tend to become clogged up on large laminates and cause a "picture frame" effect. Dimensional tolerances are easier to maintain with the low-pressure press laminate.

In contrast to both the vacuum and low-pressure press laminates, the higher pressure phenolic laminates (above 50 psi.) presents a structure that is substantially different. Porosity, as such, generally is not a problem with high-pressure press cured phenolics. The pressures exerted overcome the released volatiles by brute force, thus preventing the formation of a network of pores. This does not mean, however, that volatile problems have been eliminated. A portion of the released products of condensation remain locked in a high-pressure laminate and, under sudden heat exposure, will make themselves visibly evident.

It might be assumed that the great pressures exerted in molding a high-pressure phenolic would force out all the volatile matter. Certainly, a great portion of the residual volatiles and at least part of the products of condensation released prior to gelation are forced from the laminate. However, the curing process continues past the point where the thermosetting action has taken place, so that additional volatiles will be released with no ready means of escape. The entrapment of these volatile products in the finished product can vary from minor losses of physical properties to severe blistering, depending on the particular resin, the actual pressure-temperature cycle, the amount of heat incurred during service, etc.

Many of the customary uses to which such laminates have been placed do not tend to produce any of the serious consequences which entrapped volatile matter can cause. In the past, high-pressure phenolic laminates have been employed chiefly in uses which do not require submission to temperatures far beyond those used in curing them. For example, phenolic electrical panels are not subjected to severe temperatures except in small, isolated contact areas.

How will such laminates react as structural members of jet aircraft or missiles where they will be subjected to high temperatures over protracted periods of time? Under sudden exposure to 400 or 500° F. (or perhaps much higher), the entrapped volatiles will try to expand and, thus, produce terrific internal stresses in the laminate. In many cases, this is sufficient to cause severe blistering in the laminate. If the unattached gases in the laminate do not cause immediate blistering, the high temperature exposure, by further curing the laminate, will quickly add more volatile matter to that already present and make blistering almost inevitable. On almost any aircraft structural member, of course, a blistered part is a part which has failed. It will no longer support mechanical loads calculated with a small safety margin; it no longer maintains an aerodynamic surface; and it undergoes heat deterioration quite rapidly.

Were it not for the aforementioned unsavory features of the high-pressure phenolic, the aircraft builder might find it somewhat to his liking. Its initial mechanical properties will tend to be as high as those of its vacuum and low-pressure counterparts, and will tend to run slightly higher in the important areas of tangential and offset limits and modulus of elasticity. From a fabricating standpoint, they can be controlled to close dimensional tolerances, and generally have good aerodynamic surfaces. While tooling costs may run high for contoured parts, they are rapidly dissipated in full production so that the unit cost will tend to be lower than for the vacuum laminate. None of these advantages, how-

ever, are likely to cause an aircraft man to become enthusiastic about a type of laminate which is likely to blister as soon as it gets off the ground.

At this juncture, the future of the phenolic laminate in tomorrow's aviation would not seem particularly optimistic. On the one hand, we have harmful volatiles which must be dispersed; on the other, we have the only obvious means of dispersing them which detracts from mechanical properties and heat resistance. It is the resolution of this apparently unresolvable dilemma which is the essence of the newer phenolic laminating procedures.

## Low-Pressure Cure

Several organizations, working independently, formulated a type of molding technique for phenolics which was based on the theory that the volatile products of curing need not be provided with large exit gate-ways if they were not released in large quantities. It was believed that these volatiles could work themselves free of non-porous phenolics by means of "vapor transmission" or osmosis if released at a rate slow enough to guarantee that they could not collect and form blisters. To implement the theory, it was necessary to use sufficient pressure during the initial cure to insure that a relatively void-free condition could be obtained. Beyond this, the only purpose of the press and the accompanying heat was to get the laminate into a completely rigid thermoset condition, but to go no further.

Such a condition is not as recognizable in phenolics as it is in some other resins (polyesters, for instance) where gelation is quite sudden and visibly apparent. There are, however, one or two check-points which mark the more subtle passage of the phenolic from a "B stage" or thermoplastic to a "C-stage" or thermoset material. The most recognizable of these is a translucent appearance which it will take on immediately after the thermosetting action has been completed; especially easy to see when the phenolic is used with a colorless filler, such as glass fibers. The fact that this phenomenon passed on quickly if the laminate was permitted to cure further made it all the more valuable to the developers of the new curing procedure.

The first step, then, in the new technique, which we will call the "low temperature" cure, is to press-cure the laminate to the point of translucency. After the resin becomes thermoset, the press cure is stopped as soon as practically possible, so that there is not a large volume of released volatiles present in the laminate when the cure is continued. From this point on, all subsequent curing is carried on in an oven. The temperature of the oven cure or "postcure" is usually equivalent to the top temperature reached during the press cure. There is, of course, an entirely different heat-transfer situation in an oven than in a press; so, while the measurable temperatures may be the same, the net effect of oven heat on a laminate is much more gentle than that of press heat.

Under these conditions, the cure proceeds at a slow rate, and the volatile products of the cure are released slowly so they can escape from the laminate without causing any physical damage. For economy of time, the oven temperatures usually can be increased at intervals as the cure proceeds. This is possible because the amount of volatile matter being released is lessening, so higher oven temperatures are possible without endangering the laminate. The cure is carried to completion in the oven.

The time at which a cure can be termed "complete" with this type of curing technique must be determined individually for each phenolic formulation. It may even be varied for the same resin according to the particular use to which the laminate will be put. In general terms, the cure point may be defined as the latter chronologically of: (1) the point at which the laminate in question may be safely exposed to any temperature which it may encounter in service without any danger of damage from blistering; or (2) that point at which those mechanical properties which increase during the oven cure (tangential and offset limits and moduli of elasticity) have reached the levels where they will safely sustain the stresses to which the laminate may encounter in service. With the inclusion of appropriate safety factors in these two points, there need be no reason for carrying the cure any further. Actually, the laminate will probably undergo further curing during service exposure, but it usually is beneficial to add this additional curing time to the service life of the laminate rather than to consume it in unneeded oven curing.

The following illustrates the type of cycle employed under this theory, using one of the well known heat-resistant phenolics. The "B-stage" material is pressed at 250-260° F. for ½-hour under pressures of at least 160 psi. Hot removal is entirely permissible, but cooling under pressure is preferred to prevent possibilities of warpage due to thermal shock. Following the press cure, the laminate is post-cured 24 hours at 250° F., 24 hours at 300° F., and 24 hours at 350° F. At the end of this time, the laminate is considered to be completely cured. Its mechanical properties are within 5% of being as high as they will ever become, and it can be exposed to temperatures as high as 700-800° F. without any danger of blistering.

Table 1 shows the mechanical properties of this type of laminate under various temperature exposure conditions. These properties may be compared with the ⅛-inch laminate from the same resin by a vacuum-type cure. Figure 1 shows the void-free cross-section of a low-temperature type phenolic, as compared with the porous cross-section of a vacuum laminate.

Table 2 shows mechanical properties obtained from another phenolic used in conjunction with an asbestos

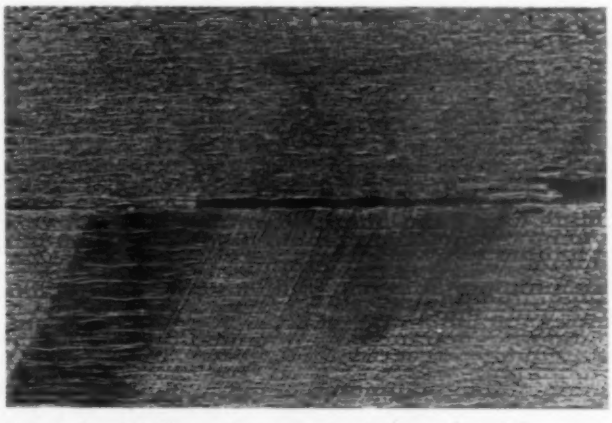

Fig. 1 Cross-sections of vacuum-cured (upper) and low-temperature cured (lower) phenolic laminates show void-free condition of latter.

**Table 2. Comparative Properties of Asbestos-Filled Phenolics Made by Standard (High-Pressure) and "Low-Pressure" Cures (All Values at Room Temp.).**

| | Standard (High-Pressure) Cure | "Low-Pressure" Cure |
|---|---|---|
| Ult. flexural strength, psi | 35,000 | 40,000 |
| After ½-hr. @ 400° F. | 26,000 | 30,000 |
| 50 hrs. @ 400° F. | 20,000* | 29,000 |
| ½-hr. @ 500° F. | 24,000* | 28,000 |
| 50 hrs. @ 500° F. | 13,000* | 21,000 |
| Modulus in flexure, psi. x $10^6$ | 3.5 | 3.9 |
| Ult. tensile strength, psi | 29,000 | 34,000 |
| Modulus in tension, psi. x $10^6$ | 3.3 | 3.6 |
| Columnar compressive strength, psi. | 23,000 | 26,500 |

* Specimen blistered.

filler. Properties are given for both the "low temperature cycle" and the high-pressure press cure recommended by the resin manufacturer. It should be noted that parts made by cycle, which the manufacturer had been employing for a number of years, tended to blister seriously when exposed to temperatures of 400-500° F.

D. M. Hatch, of the Curtiss-Wright Corp., has been employing "low temperature" type of cure for phenolics for a number of years. Mr. Hatch has found means for reducing both the molding and postcuring times so that phenolics can be made in production quantities at an amazing rate. He employs temperatures in the range of 285-300° F., but does so only for extremely short periods of time. Under ordinary circumstances, temperatures in this range tend to take a phenolic past the cure stage so rapidly that the center portion of a laminate will have passed the desired translucent optimum point while the edges are still in the "B-stage." Mr. Hatch discovered that he could bring a laminate to the translucent condition throughout by allowing it to dwell at contact pressure for a minute or two before applying molding pressure. This tends to liquefy the resin, without advancing the cure of the center part of the laminate far beyond that of the edges. He uses "hot to hot" cycles, and few of his phenolics are ever in a press for more than 6-7 minutes.

To accelerate his postcuring procedure and prevent surface oxidation, Mr. Hatch sometimes employs a molten wax. He found that the heat transfer provided by the wax was not so great that it would cause blistering under proper controls, but that it was sufficiently greater than that of an oven to cut postcuring time. Whether employing wax or an oven for postcuring, Mr. Hatch usually has a clock-driven cam attached to his temperature controls so as to slowly increase the temperature and keep it just below the blistering point. This serves to reduce postcuring time to a bare minimum. Using the methods described above, Mr. Hatch almost invariably gets the highest properties obtainable from any phenolic.

The "low temperature" type of cure differs from the average high-pressure press cure in that it attempts to take the cure barely over the brink of the "C-stage" during pressing, while the latter tries to bring the resin to a fairly advanced state of cure in the press. This difference places the ordinary high-pressure laminate under the following disadvantages: (1) it will have a greater amount of entrapped gases ready for immediate activity than its "low temperature" cured counterpart, thus be more difficult to handle in postcuring; (2) the volatile matter released and entrapped during the ordinary high-pressure cure can cause microscopic compression rupture of the resinous structure before the laminate ever gets out of the press, thus doing physical damage which no amount of postcuring can repair; and (3) some advocates of the "low temperature" cure hold that a low heat transfer cure taken from the point of initial thermosetting will provide a slightly different and stronger type of organic structure than the rapid heat transfer cure. With this latter claim, there is no supporting evidence that could not be attributed to some other factor.

"B-stage" material employed with a "low temperature" type of cure must be somewhat drier than that used for vacuum and other low-pressure molding. The drier material has a more viscous flow, thus permitting the application of sufficient pressure to assure a void-free condition without squeezing out all of the resin. Pressures used in a "low temperature" cycle may be as high as desired, but need be no higher than necessary to assure a void-free condition and obtain proper resin content

The long-time heat resistance of the "low temperature" phenolic laminate represents the best that a phenolic can attain. There is no volatile matter, either present or potential, to cause failure due to blistering, nor is there any chain of pores to permit rapid oxidation under heat exposure. Oxidation, therefore can attack the laminate only through its surfaces and the attack proceeds quite slowly because surfaces are the strongest and most heat-resistant parts of the entire cross-section. Time-temperature conditions which would reduce the properties of the low-pressure laminate far beyond any conceivable service limits would allow oxidation to penetrate the surface of a part by only a few thousandths of an inch, leaving the main body of the structure untouched and as strong as the day it was made. The values shown in Table 1 illustrate this quite pointedly.

The general mechanical properties exhibited by "low temperature" phenolics usually are as good or better than those shown by phenolics cured by other methods. The flexural, tensile, and compressive ultimates are about the same as those obtained by the other methods; the tangential and off-set limits are usually much higher. Some phenolics made by the "low temperature" method actually have no 0.2% offset strength; i.e., at the point of failure the stress-strain curve has not deviated from a straight line by as much as 0.2% of the specimen gage length. The modulus of elasticity will tend to be measurably higher than that obtainable by any other curing method.

These mechanical and heat-resistant factors make the "low temperature" cured phenolic a possible competitive aircraft material. The strengths obtainable at temperatures of 400° F. and up permit competition with aluminum and magnesium on an equal-mass basis. The great weight of aircraft steels enables phenolics to compete with them in centrifugally-loaded parts, since the load on a centrifugal member is a product of its own weight.

*(Continued on page 597)*

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# Plasticizer Problems in Vinyl Resin Studies

**The fundamental concepts of plasticizer compatibility and weight loss needed for engineering design of plasticized vinyl compounds.**

PLASTICIZERS are used with vinyl chloride resins to impart flexibility to the resin. By incorporating a plasticizer, the resin can be changed from a tough, rigid material to a flexible plastic that has many uses. Plasticizers are a special class of resin solvents, and the primary characteristic which differentiates them from ordinary solvents is volatility. Low volatility is necessary to ensure that the article containing the plasticizer remains flexible during prolonged service. However, plasticizers are solvents for the resin, and the thermodynamics which have been developed for solutions of resins can also be predicated to hold true for plasticizers.

Permanence is probably the most important property that determines the general utility of a plasticizer. There are two general aspects to the concept of plasticizer permanence. In the first place, it is necessary that the plasticizer be a true solvent for the resin; otherwise, a phase separation can be expected, and an undesirable exudate will appear on the surface of the article. Compatibility is the general term which covers this aspect of plasticizer permanence. Secondly, even though the plasticizer selected is compatible with the resin, it may be of a type that is readily lost by volatilization, water extraction, or by some other means.

These two types of plasticizer loss are best treated separately. Therefore, the conditions which determine whether a plasticizer is compatible will be discussed first. Then, the experimental results and relationships which have been found for loss of compatible-type plasticizers because of the environment in which they are placed will be considered.

## Thermodynamic Compatibility

The thermodynamic treatment of solubility or compatibility is based on the second law of thermodynamics. Accordingly, in order for a system of two components to be mutually soluble, $\Delta F$ in the equation $\Delta F = \Delta H - T\Delta S$ must be negative. Using this equation, Flory and Rehner (1)* have derived an expression which relates the degree of swelling of a cross-linked polymer in a solvent to the Flory-Huggins $\mu$ resin-solvent interaction constant and the average molecular weight between network junctures in the cross-linked network. Doty and Zable (2) have applied this equation to various vinyl chloride resin solvents and plasticizers with excel-

* Numbers in parentheses refer to bibliography at end of article.

**Table 1. $\mu$-Values for Polyvinyl Chloride and Various Liquids at 53° C.**

| | |
|---|---|
| Trioctyl phosphate | —0.85 |
| Dioctyl phthalate | 0.01 |
| Dihexyl adipate | 0.19 |
| Dihexyl sebacate | 0.34 |
| Tricresyl phosphate | 0.38 |
| Dimethyl phthalate | 0.56 |
| Methylacetyl ricinoleate | 0.56 |
| Acetone | 0.60 |

**Table 2. Correlation of Plasticizer Solvating Power (as Measured by Flory-Huggins $\mu$) and Slope (n) of Log Molulus-Log Volume Concentration Plot.**

| Phthalate Ester | $\mu$ at 53° C. | n at 30° C. |
|---|---|---|
| Dihexyl | —0.13 | 3.62 |
| Dibutyl | —0.04 | 3.90 |
| Dioctyl | —0.01 | — |
| Diethyl | 0.42 | 3.74 |
| Dimethyl | 0.56 | 3.51 |
| Di 2-ethylhexyl | — | 3.47 |
| Dinonyl | — | 3.42 |
| Didodecyl | 1.75 | 3.22 |

lent results. Table 1 gives $\mu$ values selected from their data. The Flory-Rehner theory predicts that solvents with a $\mu$ value less than 0.54 are compatible in all proportions with the resin, and this prediction is borne out remarkably well. For example, acetone is not a solvent at room temperature. However, its $\mu$ value decreases to less than 0.54 at high temperatures, and miscibility in all proportions is obtained at these temperatures.

The compatibility of a plasticizer can be related to its volume concentration and its $\mu$ value. Figure 1, taken from Doty's work (3), shows the phase equilibrium curves for polymers containing (m) monomer units. As

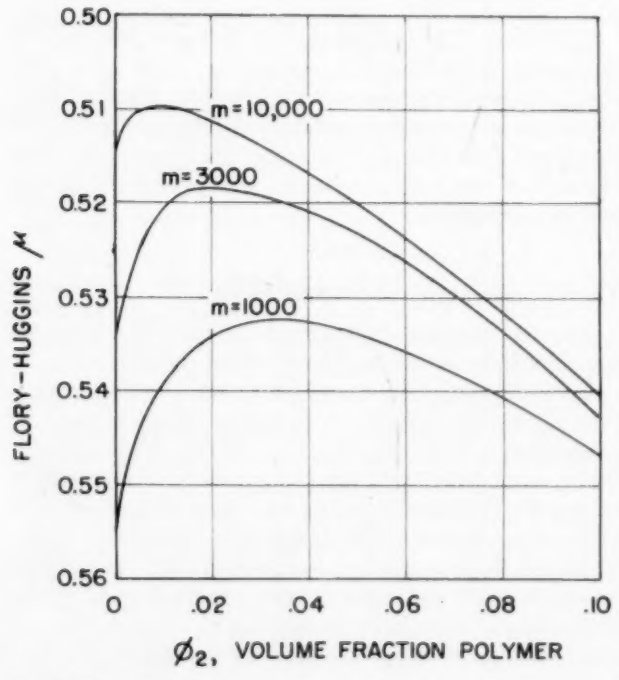



**Fig. 1. Phase equilibrium curves for polymers of various degrees of polymerization.**

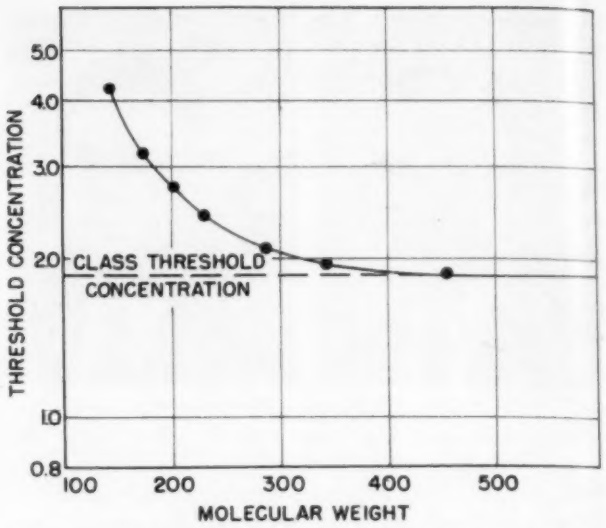



**Fig. 2. Threshold concentrations of vinyl chloride-acetate resin VYNS vs. molecular weights for di n-alkyl succinates homologous series in n-heptane at 50° C.**

can be seen, at volume fractions of polymer higher than about 0.04, the critical $\mu$ for phase separation increases with increasing polymer concentration. Therefore, a plasticizer with a $\mu$-value significantly greater than 0.54 will show limited compatibility. Doty estimates that a liquid with a $\mu$-value of 1.2 is compatible with the resin up to a volume concentration of 20%.

In order to explain certain aspects of behavior of plasticized vinyl chloride resins, the simple concentrated solution concept does not suffice. As shown by Alfrey, Wiederhorn, Stein and Tobolsky (4), X-ray diffraction reveals the presence of crystallites in these materials. The crystallites plus the resin chains form a network structure which is responsible for the elastic recovery properties.

Walter (5) has postulated that plasticizers which are strong solvents prevent or retard crystallinization of the polymer. Strong solvent-type plasticizers, therefore, suppress the formation of the three-dimensional network and, thus, reduce the elasticity modulus of the plasticized resin. When the long volume concentration ($\sqrt{}_o$) is plotted against the log of modulus in the resin concentration range of 5-30%, straight lines which have the equation $M - C_1 (\sqrt{}_o)^n$ are obtained. The slope of these lines, n, show an inverse relationship to the Flory-Huggins $\mu$-value.

In Table 2, Walter's slope values, n, are compared to $\mu$ values obtained by Doty and Zable on a homologous series of dialkyl phthalates. Walter obtained the highest n-value, which corresponds to the strongest solvating action, for the dibutyl ester. While Doty and Zable found a minimum $\mu$ for dihexyl phthalate, the general trend in both cases is similar. This similarity tends to lend credence to Walter's concept of the effect of plasticizer solvent power on the structure of the plasticized network.

Another interesting approach to the mechanism of plasticization has been made by Doolittle (6). This is based on the measurement of solvating power of a homologous series such as the di n-alkyl phthalates and the tri n-alkyl phosphates. A solution of the resin is made, and a non-solvent type diluent is added until

phase separation occurs. This is done in such a way that the solids content of the system is 0.5 grams of resin per 100 milliliters of total liquids at the precipitation point. The concentration of solvent in moles per liter of total liquids at the end-point is called the "threshold concentration, $n_{DR}$."

When this is done for a homologous series, $n_{DR}$ can be plotted against the molecular weight (as shown in Figure 2) for vinyl chloride-acetate resin VYNS in di n-alkyl succinates with n-heptane diluent. As the molecular weight of the solvent increases, a limiting value called the "class threshold concentration, $n_E$" is approached. The solvating power is, of course, inversely proportional to the class threshold concentration. Doolittle has attempted to apply this to plasticized resin systems, but with only limited success. The difficulty appears to be due to the dependence of the threshold values on resin concentration. Measurement of phase separation at high resin concentrations on addition of diluent is extremely difficult.

The basic compatibility of a plasticizer is tested by compounding it with a vinyl resin and appropriate stabilizer and lubricant, then storing the resulting film or sheet and examining it at regular intervals. A total test time of two weeks is usually sufficient. An exudate, if present, may be solid, semi-solid, or liquid in form. These are usually referred to as bloom, tackiness, and sweat-out, respectively.

A simple examination by observation and touch is generally sufficient to establish the presence or absence of exudate and to characterize it. A more sensitive test for sweat-out may be made by wiping the sample with a cigarette paper and examining the paper for evidence of transparency. Another quite sensitive test consists of momentarily holding the sample against a ground glass under light pressure, then examining the ground glass for an area of increased transparency.

In general, a plasticizer molecule containing only aliphatic carbons is more likely to exude. Partially aromatic molecules, such as di 2-ethylhexyl phthalate, almost always are compatible. Exudation is more likely to occur at high plasticizer concentrations. A plasticizer of limited compatibility may often be used satisfactorily in combination with one of good compatibility. An example of this is the use of chlorinated paraffins which exude very rapidly if used alone, but are quite satisfactory if combined with di 2-ethylhexyl phthalate (Flexol plasticizer DOP) in a 1:4 ratio.

The compatibility of some plasticizers is adversely affected by environment. For example, storage at high humidity will cause exudation with some polymeric type plasticizers, some epoxide derivatives, and most esters of aliphatic dibasic acids.

A loss of compatibility due to chemical change also is a problem with some materials. This may be shown by exposure in a sunlit window or to a Type RS Sunlamp. An example is found in vegetable oil epoxides containing unreacted double bonds, and has led to the general rejection of unsaturated materials as plasticizers in vinyl compounds.

The idea of applying light pressure on a sample held against a ground glass can be extended to higher pressures and longer periods of time. This approach is not suitable as a simple compatibility test method, since materials which exude under pressure will not necessarily do so in service. However, the test is interesting in that the results show some relation to the value of $\mu$ obtained from liquid-polymer swelling measurements by Doty and Zable. Measurements were made over a range of times and pressures up to 120 minutes and 40 psi.

Table 3 shows data for five plasticizers at 40 parts per hundred of resin as compared with the $\mu$ values. The first four plasticizers did not exude under the maximum conditions tested, while di 2-ethylhexyl sebacate exudes at a very low pressure and time. A similar exudation of less compatible type plasticizers can sometimes be detected on the inside radii of sheets which have been stored in a folded position.

## Mechanism of Plasticizer Loss

The foregoing discussion has concerned itself with plasticizer exudation which takes place because of the lack of mutual solubility of the resin with the plasticizer or with the degradation products of the plasticizer. Interaction of the plasticized resin with its environment is not necessary for this type of exudation, except in the special sense that chemical changes in the plasticizer are due to reaction with light or air. This type of plasticizer loss is very important to the chemist who synthesizes new plasticizers since any material worthy of commercial development must be compatible and chemically stable.

To the compounder who formulates commercial plasticizers into finished products, plasticizer losses due to the effect of the environment on the resin-plasticizer system are probably more important, since we can assume that incompatible or chemically unstable plasticizers are of limited commercial importance. In this latter category are the many tests which have been developed to measure the susceptibility of plasticized compounds to their environment. To mention a few, we have oven aging, oil and gasoline extraction, water ex-

**Table 3. Relationship of Plasticizer $\mu$-Valve to Exudation.**

| Plasticizer | $\mu$ at 53° C. | Minimum Time and Pressure to Exude | |
|---|---|---|---|
| | | Minutes | Psi. |
| Trioctyl phosphate | —0.85 | >120 | >40 |
| Dihexyl phthalate | —0.13 | >120 | >40 |
| Di 2-ethylhexyl phthalate | 0.01 | >120 | >40 |
| Tricresyl phosphate | 0.38 | >120 | >40 |
| Di 2-ethylhexyl sebacate | 0.59 | 1 | 5 |

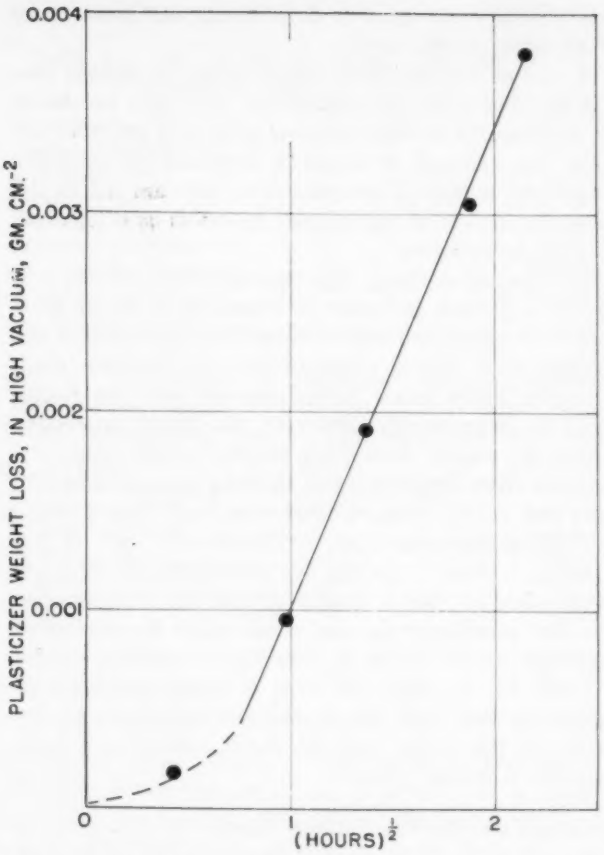



Fig. 3. Effect of time on plasticizer weight loss at $10^{-4}$ mm. mercury (0.018-in. thick vinyl sheet containing 65 phr. di-2-ethylhexyl adipate).

traction, and dilute soap extraction tests. Usually, although unfortunately not always, these tests are designed to duplicate as nearly as possible the conditions which are met in practice. The better empirical tests of this type give data which are useful, but these tests provide little insight into the mechanism or the principles underlying plasticizer loss.

In recent years some progress has been made in understanding plasticizer migration and plasticizer loss. The concepts involved are simple: In order for a plasticizer molecule to escape from the sample, it must first migrate to the surface; then, by reason of its vapor pressure or because of the environment in which it is placed, it escapes into the surrounding medium. The rate at which the plasticizer escapes from the surface of the specimen is all-important. At ordinary temperatures, plasticizers with low vapor pressures will evaporate at a very low rate. Increasing the temperature or placing the specimen in certain environments permits a faster escape from the surface. For example, a 0.004-inch specimen plasticized with 48 phr. of di 2-ethylhexyl phthalate (Flexol plasticizer DOP) loses 5% of its weight when immersed for two hours in mineral oil at 50° C. The estimated time for this compound to lose 5% of its weight in air at the same temperature is about one year.

## Diffusion-Controlled Loss Rate

Liebhafsky, Marshall, and Verhoek (7), Small (8), and Quackenbos (9) have shown that under certain conditions, the plasticizer escapes from the specimen as quickly as it reaches the surface. This type of loss takes place in a high vacuum. Under these conditions, the rate of plasticizer migration to the surface controls the plasticizer loss rate. Since migration of the plasticizer within the specimen is a diffusion phenomenon, the laws of diffusion kinetics can be applied. For example, in a vacuum of $10^{-4}$ mm. mercury, the weight loss plotted against the square root of time is a straight line. This is shown in Figure 3, which is taken from Quackenbos's paper. Since the square root of time relationship is a necessary condition for diffusion-controlled loss, and since the same loss rate curve is obtained at $10^{-3}$ mm. mercury but not at $10^{-2}$ mm., Quackenbos assumes that the rate of loss is controlled by the rate of diffusion inside the vinyl sheet.

A high vacuum is not the only environment in which plasticizer is lost as quickly as it reaches the surface. Reed, Schulz, and Klemm (10) have investigated the loss rate at 50° C. in mineral oil and in 5% soap solution. In general, the same rate of loss is obtained as in a high vacuum. Geenty (11) has shown that when plasticized vinyl films are packed in a fine, absorbent powder and held at a pressure of 10 psi., a considerable quantity of plasticizer is removed. Reed, Schulz, and Klemm have modified Geenty's method by constructing an apparatus that continuously rotates the test specimen through the powder. When a 50-50 mixture of finely divided calcium silicate (Silene EF) and diatomaceous earth (Hyflo-Super-Cel) is used as the absorbent powder, the rate of plasticizer loss is equal to that obtained in a high vacuum.

A tabulation of data taken from their paper and some additional figures are shown in Table 4. The k values listed are the slopes of the lines obtained by plotting per cent weight loss versus the square root of hours. This plot is linear up to 10% weight loss, while at weight losses of less than 3% the k values are somewhat erratic. Therefore, the test is run for whatever time is necessary to give a weight loss between 3% and 10%. In general, the agreement among the three tests is excellent. The only discrepancy is the mineral oil extraction of the

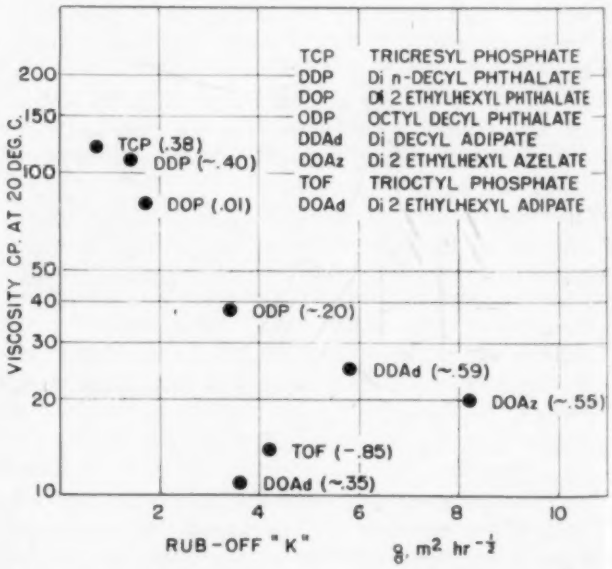



Fig. 4. Effect of plasticizer viscosity on rub-off constant of vinyl compound containing 50 phr. plasticizer. $\mu$-Value is shown for each point.

Table 4. Plasticizer Loss Rates in Various Environments.

| Plasticizer | Conc., Phr.* | K-Value** Oil | Rub-off | Soap |
|---|---|---|---|---|
| Di 2-ethylhexyl adipate (Flexol A-26) | 40 | 3.9 | 4.0 | 3.3 |
| | 50 | 5.4 | 6.2 | 4.6 |
| | 70 | 11.0 | 11.6 | 7.1 |
| Di 2-ethylhexyl phthalate (Flexol DOP) | 40 | 0.9 | 1.2 | 0.8 |
| | 50 | 2.0 | 2.0 | 1.0 |
| | 70 | 4.8 | 4.9 | 2.2 |
| Tri 2-ethylhexyl phosphate (Flexol TOF) | 40 | 3.0 | 2.5 | 2.8 |
| | 50 | 4.7 | 4.3 | 4.0 |
| | 70 | 7.7 | 5.8 | 6.1 |
| Butylbenzyl phthalate (Santicizer 160) | 40 | 0.8 | 1.0 | 0.9 |
| | 50 | 1.7 | 1.6 | 1.9 |
| | 70 | 4.9 | 4.1 | 4.9 |
| Polyester (Flexol R2H) | 50 | Gain | 0.2 | — |
| | 70 | " | 0.2 | — |
| | 90 | " | 1.3 | — |

* Parts by weight plasticizer per 100 parts resin.
** For 0.004-inch thick films at 50° C.

sample containing the resinous type plasticizer, Flexol R2H, and this is due to a small amount of mineral oil absorbed by the specimen. Since the large molecules of Flexol plasticizer R2H diffuse very slowly, the effect of their removal is overshadowed by the amount of mineral oil absorbed.

The suggestion has been advanced previously that the viscosity of a plasticizer should be related in a general way to its diffusion-controlled loss rate. Like all generalizations of this type, some discrepancies occur. It appears to the authors that one factor which also affects diffusion is compatibility, as measured by the $\mu$ factor. In Figure 4, rub-off constants measured at a plasticizer concentration of 50 phr. resin are plotted against the log of viscosity. $\mu$ values obtained either directly from Doty and Zable's data or interpolated from their results are given for each point. It will be noted that the two plasticizers of borderline compatibility ($\mu = 0.54$) have higher rub-off values than would be expected from their viscosities.

One more point should be made about diffusion-controlled plasticizer loss. In certain types of environments, it is possible to obtain rates higher than those obtained in high vacuum, mineral oil, 5% soap, or rub-off. Gasoline extraction is typical, and Table 5 compares plasticizer weight loss figures for a Flexol plasticizer DOP compound in gasoline and in mineral oil. A considerable amount of gasoline is taken up by the vinyl sheet, and this imbibed gasoline must be removed by drying in order to determine how much plasticizer is lost.

Table 5. Comparison of Plasticizer Extractants.

| | Weight Loss, % |
|---|---|
| 2 hrs. in gasoline at room temperature for 0.020-in. sheet | 14.9 |
| 2 hrs. in mineral oil at 50° C. for 0.004-in. film | 5.0 |
| Formulation: | |
| Vinyl chloride-acetate copolymer VYNW | 100 parts |
| FLEXOL plasticizer DOP | 48 parts |

Despite the fact that the gasoline extraction is run at a lower temperature and on a thicker sheet, the amount of plasticizer loss is greater than with mineral oil. The imbibed gasoline apparently swells the structure of the plasticized compound, allowing the plasticizer to diffuse out at an accelerated rate. Plasticizer extraction tests in which the extraction medium is taken up by the vinyl sheet represent a new loss mechanism which might be called super-diffusion loss.

### Surface Resistance-Controlled Loss

The historical method for evaluating plasticizer volatility is by an oven test at some elevated temperature, usually in the range of 60-100° C. This is an example where rate of loss is dependent on resistance to loss at the surface. The surface resistance, in turn, is a function of rate of air flow and vapor pressure. Such tests are very critical as to test conditions, and interference between samples due to vapor condensation on sample and oven surfaces and errors due to differential air flow are major problems. These problems were effectively solved by Reed (12) with a multicell oven. The precision of Reed's test, run at 60° C., was improved by Quackenbos (9) by raising the temperature to 98° C.

The ASTM test for volatile loss from plastic materials (13), widely used at present, employs activated carbon in direct contact with the sample to adsorb plasticizer and prevent saturation of the surrounding atmosphere. A drawback, here, is possible wicking action by the carbon in addition to volatile loss. A marked acceleration of loss, compared to conventional oven tests, is obtained. When this test is run at higher temperatures, such as 90° C., the loss may approach diffusion-controlled conditions.

In oven volatility testing, as well as in compatibility, chemical changes such as oxidation may become impor-

tant, especially at or above 100° C. Where no chemical change occurs, vapor pressure is the controlling factor in plasticizer volatility and can be used to predict compound life, as shown by Quackenbos.

Another example of surface-controlled loss is extraction by water. Here, the solubility of the plasticizer in the extractant is very low and, as in the loss in air, test conditions such as rate of flow past the sample are very critical. In static tests, saturation of the water is readily achieved, extraction is usually low, and results can be misleading. Water must be changed frequently or flow continuously past the sample. Here, also, activated carbon has been used by Schulz (14) with some success to prevent saturation. Theoretically, a means of measuring solubility of plasticizers in water would be the best way to predict water extraction, but this does not work out in practice. Quackenbos found that water saturated with plasticizer would still extract more plasticizer from a vinyl film in some cases. He proposes a mechanism combining absorption of water followed by exudation of plasticizer and resultant loss from the film surface.

The diffusion-controlled character of extraction by 5% soap solution has been discussed above. This does not hold for the more dilute solutions (¼-1%) which are commonly used in laundering. Here, the solubility of plasticizer in the solution is the controlling factor. Since this is influenced by temperature and volume of solution, the conditions of the test are quite critical, as is also the case with water extraction and loss into air. The situation is further complicated by the absorption of soap into the vinyl compound during the early part of the test. Since this occurs simultaneously with loss of plasticizer, the overall change in weight does not accurately reflect what is taking place.

Because of the complications involved in extraction by dilute soap solution, it is difficult to obtain results which agree well by different test methods. Perhaps the best approach is that of actual laundering of the vinyl film under carefully controlled conditions.

## Areas for Future Study

It is possible that the cases where extraction is controlled by diffusion are seldom met in practice. Exposure to rubbing action or oil usually is intermittent rather than continuous. It is important to establish whether this will affect the basic diffusion-controlled mechanism and, thus, whether data obtained in continuous measurements accurately predict service life.

It would be desirable generally to adopt an engineering approach in designing plasticized vinyl compounds. The concept of a service life and the idea of calculating properties from known data are both steps in this direction (9, 15). The present method of reporting per cent weight loss alone should be abandoned.

More practical and precise tests are needed for launderability and water extraction.

The concept of solubility parameter, which has been applied so successfully to solutions of resins, may also be applicable to plasticized resins (16). It may be possible that combinations of incompatible plasticizers, both of which are incompatible when used alone, will be

*(Continued on page 590)*

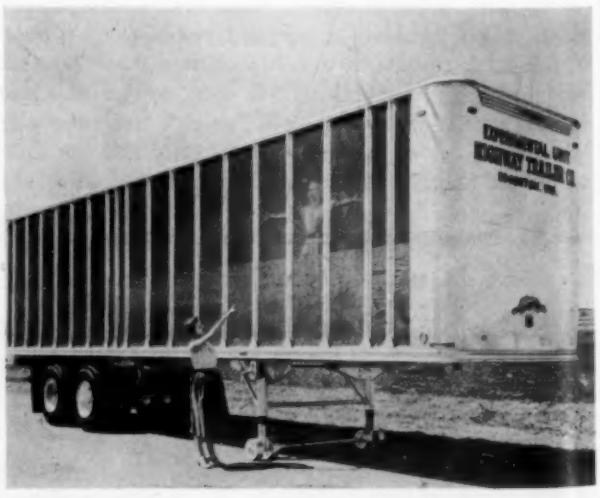
# Reinforced Plastic Truck-Trailer

An experimental truck-trailer with reinforced-plastic side walls and roof has passed preliminary road tests carrying a 43,000-pound load, and is now scheduled for exhaustive operational trial by several Midwestern trucking firms. Built by the Highway Trailer Co., a division of Merritt-Chapman & Scott Corp.'s equipment department, the unit was designed specifically to test the structural capabilities of plastics in heavy-duty, commercial truck-trailers.

Advantages of the fibrous glass-reinforced polyester panels and roof are reportedly two-fold: an appreciable reduction in weight, with resultant economies; and better interior lighting. Wall panels are blue, with the roof skin an aluminum color. In both cases the color is impregnated into the resin, thereby eliminating the need for periodic painting.

Wall panels, 0.5-inch thick, are lined with plywood and riveted to vertical aluminum posts and longitudinals. The one-piece roof sheet measures roughly 34½ by 7¾ feet, and is 0.024-inch thick. Front and rear panels are of 0.048-inch clad aluminum with plywood lining.

—The End



Truck-trailer features translucent, reinforced plastic roof and side panels.

*Guest Editorial*

THEODORE H. SILBERT, *President*
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# Tighter Credit for Plastics Companies

In a study of 727 manufacturers and 127 banks in every major city in the country, we found that something significant is happening in the United States; something of major significance to the plastics industry in particular. We inaugurated the study in April 1955 when the Federal Reserve Board announced its first hike in the rediscount rate and tightening of credit. We closed our study right after the fifth boost in rediscount rate was announced in April 1956.

Our study found that not only did the bank interest rates go up and up but, more important, credit was being tightened so drastically that smaller firms were being squeezed out of bank credit entirely. The following table summarizes our findings on bank credit:

| Net Worth Of Companies | Per Cent of Companies with Bank Lines | |
|---|---|---|
| | March 1955 | March 1956 |
| $5,000 to $25,000 | 53 | 18 |
| $25,000 to $100,000 | 82 | 44 |
| $100,000 to $500,000 | 94 | 79 |
| $500,000 to $1,000,000 | 99 | 98 |
| $1,000,000 to $2,500,000 | 99 | 98 |
| Over $2,500,000 | 99 | 99 |

It is obvious from this table how the smaller companies have been severely affected by the bank credit squeeze.

Why is this of particular importance to the plastics industry? The plastics industry is composed of three segments:

(1) The producers of basic raw materials for plastics. These manufacturers of basic raw materials are the giants of the industry, but are the fewest in number. There are only about 50 or 60 in the whole country.

(2) The processors who buy the raw materials and process the plastics in large quantities or sizes; e.g., miles of vinyl sheeting, yards of reinforced plastic sheet, miles of plastic tubing or rods, etc. Of the processors, most are medium-sized companies. There are about 2,000 processors in the country.

(3) The fabricators and finishers who receive the sheets, tubes, or rods, and manufacture consumer end-items ranging from jewelry to toys, raincoats, automobile instrument panels, etc. The fabricators and finishers are the most numerous; there are about 3,000 of these companies in the country.

The first segment has no problem of bank lines, public financing, and long-term insurance company loans. The second segment has some difficulty in getting bank accommodations, while the third segment has the utmost difficulty.

What accounts for the shortage of working capital and bank lines for most of the fabricators and for some of the processors? Banks do not normally lend to molders or extruders for the pur-

*(Continued on next page)*

chase of presses or other equipment, since these are highly specialized in character and do not meet the normal criteria for collateral on bank loans. Special equipment used in making plastic bottles is also regarded in the same unfavorable light by financial officers. So is the equipment used for the production of reinforced plastic pipe, radio cabinets, fishing rods, etc. Bank officers are similarly unimpressed by raw or semi-processed plastic inventories. Many of the industry's raw materials and uncured plastics have a short shelf-life and, therefore, are not sound collateral for bank loans.

It is for such reasons that fabricators and finishers find it difficult to expand without selling a big share of their business. They have no way of acquiring the big investment necessary for presses, preheaters, preforming, and materials handling equipment unless they sell out and become a small part of a larger company. The new squeeze on bank credit affects the plastics industry perhaps more severely than any other industry, mainly because there are so many smaller firms in this field.

What of the future? Standard Factors Corp. has worked out a plan in cooperation with several other leading commercial finance companies whereby plastics companies being turned down on bank financing can still avail themselves of vital credit. Sometimes a bank will turn down a plastics company's application for credit for reasons unconnected with the situation in that particular business. For example, a plastics company may not meet the eligibility requirements of a bank because the bank demands certain ratios; or a plastics company may not be able to get an immediate increase in bank lines when confronted with an increase in volume of business.

In circumstances such as these, Standard Factors, in cooperation with other commercial finance companies, has supplied the needed working capital mainly because we have seen the plastics industry grow from a seed until today there are about 5,000 companies in the field. A growth industry such as this stifles easily without the needed security of ready working capital.

Actually, we know from our research in the plastics industry that short-term funds are not the major need of plastics manufacturers. They need long-term loans, three to five year maturities. The new accounts receivable plan which Standard Factors has worked up for the commercial finance industry, involves no cleanup; the funds are there for as long as the firm needs them to grow on. No compensating balances are required, nor collateral red-tape. Moreover, these financial arrangements are confidential; the era of old-line factoring when customers were notified to pay their invoices to a factor was outmoded when Standard Factors brought out its new non-notification plan.

Our studies of the plastics industry indicate that some plastics companies might do well with straight bank credit, some with insurance company loans, some with chattel mortgage loans, some by accounts receivable financing, and some by stock flotations, depending on the company's size, the current status of the Federal Reserve Board credit policy, and the growth possibilities of the individual company.

So long as a business is a going business with reasonable outlook for growth and expansion, the Standard Factors plan available through several related commercial finance companies can meet that company's problems. All that is required is some energy and initiative by the company management in investigating the various sources of finance and evaluating what they have to offer for that particular business. —THE END

(PLASTICS TECHNOLOGY *does not censor in any way the opinions expressed by authors of our Guest Editorials.*)

**Plasticizer Problems in Vinyl Resin Studies**

(*Continued from page 588*)

compatible as a mixture. This would be likely if the solubility parameter of one plasticizer is lower than polyvinyl chloride, while the other has a higher parameter.

More fundamental data on the relation of molecular structures of plasticizers to their properties in resins are needed. This would help in designing new plasticizers with enhanced performance.

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—THE END

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# Insert Types and Installation Techniques for Metal Threads in Plastic

**A discussion of the design types of wire inserts and their installation in plastic parts to provide screw threads.**

THE problem of obtaining metal threads in plastics was first solved by solid metal bushings. These solid bushings, however, also created problems. Being solid, and embodying knurls, fins, annular grooves, and the like, they tend to concentrate stresses set up by the cooling and shrinkage of the plastic, and to precipitate cracking. Staking with pins is sometimes required to hold the bushing. Depending on bushing thickness, the designer must allow for extra wall thickness of bosses and greater edge distance.

Several new methods of putting strong, permanent metal threads into plastics have been developed, involving three types of wire thread inserts. Manufactured of stainless steel, phosphor bronze, plated carbon steel, and other metals, both internal and external threads in standard sizes ranging from No. 4 through 1½ inches can be obtained in all varieties of plastics. In addition, larger or smaller thread sizes and left-hand threads can be obtained with special wire thread inserts.

Not only can strong, wear-resistant threads be achieved in plastics, but it is also possible to provide a locking effect on the machine screw when desired. The inserts are flexible, being formed from wire, and permit shrinkage of the parent material without cracking around the insert. Wire thread inserts occupy a minimum of space, and can easily be incorporated into existing designs without the need for major design change.

## Types of Inserts

Three types of inserts are available to the plastic designer, molder, and user with several methods of installation:

(1) The standard insert with tang (see Figure 1). This

Fig. 1. Standard inserts with tang for plastics.

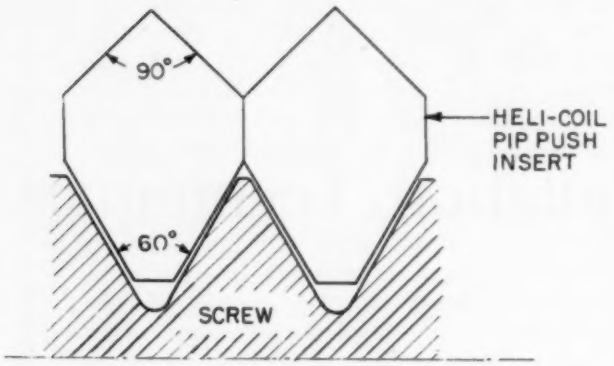


Fig. 2. Cross-sectional view through Pip push insert and screw.

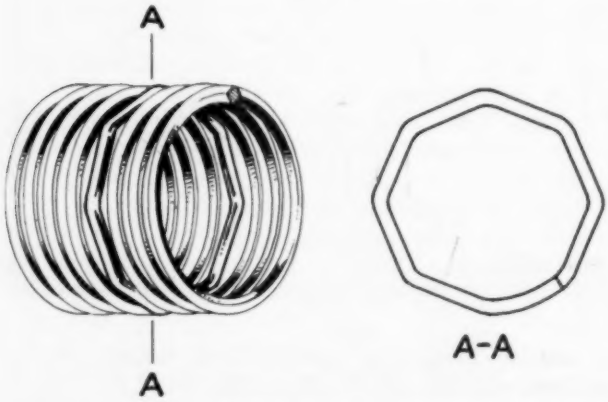


Fig. 3. Screw-lock (mid-grip) insert, showing polygon-shaped locking coil.

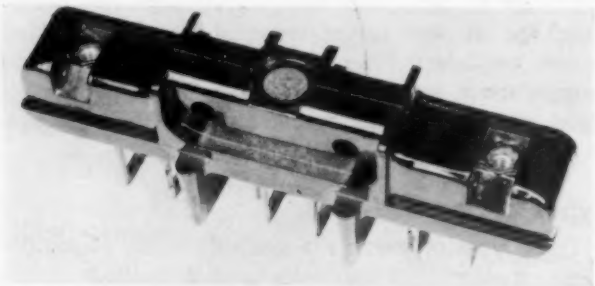

Fig. 4. Standard inserts used to salvage plastic electric switch part.

insert is wound or turned into prepared threads, and the adjoining coils do not touch.

(2) The new Pip push insert (see Figure 2). This insert has no tang and is pushed straight into an unthreaded hole. The adjoining coils are in contact, and a flat surface on the sides of the coils permits axial pressure without displacing the coils.

(3) The new screw-lock (mid-grip) insert (see Figure 3). This type of insert not only gives strong, wear-resistant threads in plastic the same as the standard insert, but also exerts a strong locking effect on the screw fastener, which eliminates the use of locking devices such as lock-washers, lock-nuts, and locking wires. One or two coils in the middle of the insert approximate a polygon instead of being round. As the screw passes through the insert, it forces the grip coil to assume a circular shape. The chords of the "circle" press on the screw, giving a gripping effect which is not diminished through many cycles of disassembly.

## Standard Inserts

Greater tensile and torsion strength, and a better class of fit can be obtained with the standard insert installed into preformed threads than with Pip push inserts pushed into a cylindrical hole. Less design changes are required when incorporating standard inserts as original equipment in established parts than when push inserts are added. In addition, standard inserts are more readily adaptable to installation for salvage work or field repairs than are push inserts.

These advantages require an insert that is more expensive initially and takes added operations to install than a Pip insert. There are three methods of installing the standard insert, each one requiring that a thread be formed in the parent material, and that the insert be wound or turned into the prepared thread.

The first method requires drilling a hole to correct size, tapping a thread, and winding the insert into position. Inserts originally installed as a salvage operation to reclaim typical electric switch parts are now installed on the production line by using this method (see Figure 4).

Using the second method, a hole of the correct dimension may be molded in position, the thread tapped, and the insert wound in. The third method requires that a thread be molded in the proper position in a part, and the insert wound into the molded thread. Inserts are installed in phenolic camera bodies by this method (see Figure 5).

## Push-In Inserts

The Pip push insert provides a low-cost method of obtaining metal threads in plastics where severe loads are not encountered, but where resistance to wear from frequent assembly and disassembly is required. The Pip insert is inexpensive, and can be purchased and installed for less than one cent per hole. Tooling requirements for production runs, involving rates as high as 1200 pieces per hour, are simple. A Pip mandrel, the only tool necessary for installing these inserts, can be used in conjunction with any machine or device (such as a drill

press, kick press, arbor press, or hydraulic cylinder) which has a suitable stroke.

This insert is slightly larger in diameter than the hole into which it is pushed. When installed, the insert has a tendency to expand and return to its original size, thereby pressing itself into or against (depending on the material) the walls of the hole. In addition, for greater resistance to pull-out, a run-out thread on the screw is used. This thread will wedge the top coil with greater force into or against the walls of the hole. Holes can be drilled or molded. A typical application employing this method of installation is the electric socket cap shown in Figure 6.

A second method of securing the insert in the hole, when greater strength is required, is to use the insert in a through hole, which has been counterbored, and install it from the back (see Figure 7). The insert presses against the shoulder as the screw is tightened. The hole can be provided by drilling and counterboring, drilling with a step-drill, or molding it in position.

### Mid-Grip Inserts

The newest member of the wire type screw thread insert family is the mid-grip screw-lock insert which has been described previously. The installation techniques for this insert are similar to those used for standard inserts.

## Installation by Molding

Methods of installation discussed up to this point involve installation of inserts after a part has been molded. Both standard and modified screw-locking Pip inserts can be molded in position during the conventional molding cycle. This method may prove to be the least expensive in many instances, depending on the molding technique used, for no secondary installation operations are required. Increased strength is another advantage of this method.

Threaded core pins may be used in the molding operation. The polyethylene carbonator part, shown in Figure 8, has inserts which were molded in position on a threaded core pin.

## Insert Materials

The standard wire insert has long been made in either stainless steel or phosphor bronze. Inserts of the types described in this paper are available in these two materials. In addition, inserts can be made of many other materials, such as carbon steel and red brass.

## Summary and Conclusions

Three distinct installation approaches may be taken when using wire-type screw thread inserts to provide metal threads in plastic parts. These threads may be either internal or external and, in the case of internal threads, can provide a locking action on the screw, if so desired.

Conventional or standard inserts can be installed by any of the following methods: (a) drill-tap-wind insert in; (b) mold hole-tap-wind insert in; or (c) mold thread-wind insert in.

Push-in (Pip inserts) can be installed by pushing them into drilled or molded holes when using runout screws.

Fig. 5. Standard insert installed in molded hole in phenolic camera body.

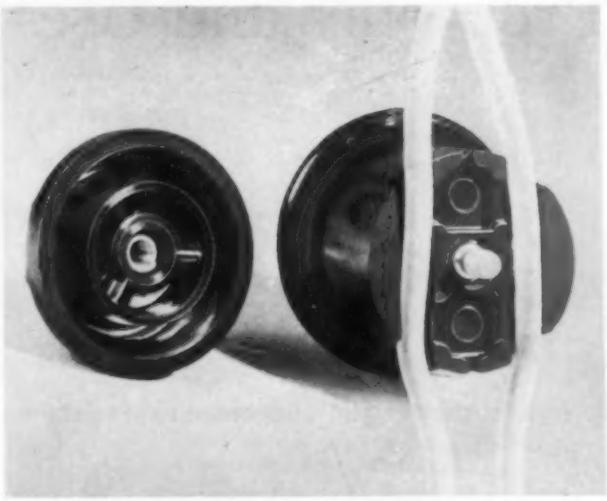

Fig. 6. Pip push-in insert installed in plastic electric socket cap.

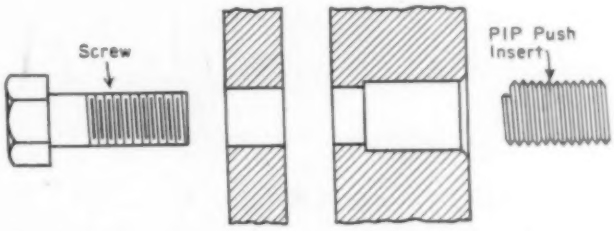


Fig. 7. Cross-sectional drawing of Pip insert installation in counterbored through-hole.

Fig. 8. Polyethylene carbonator part has inserts molded in position on a threaded core pin.

When using the shoulder principle, Pip inserts can be pushed into step-drilled, drilled-and-counterbored, or molded-in holes.

Threaded core pins are used when molding in holes for internal threads obtained with either Pip or mid-grip inserts.

—The End

# Properties and Uses of Polyethylene Pipe*

**Burst, creep strength, and chemical resistance of the pipe are considered in relation to applications.**

CHESTER G. BRAGAW, JR., *Research Engineer*

*Experimental Station, Polychemicals Dept.,*

*E. I. du Pont de Nemours & Co., Inc.*

*Wilmington, Del.*

THE growth in use of plastic pipe in general and of polyethylene pipe, in particular, is attested by production figures. Although reliable figures are hard to get, our indications are that 1954 output of polyethylene pipe was in the neighborhood of 35-million pounds out of perhaps a 46-million pound total for plastic pipe. The output for 1955 may have exceeded 55-million pounds in the United States alone.

Why is polyethylene pipe so popular? It has outstanding resistance to corrosion, and it does not contaminate pipe contents. Its flexibility allows it to be used where freezing of contents is possible, and it has excellent resistance to mechanical shock. It is inexpensive because of its flexibility, light weight, and availability in long coils. It is cheap to install, and few fittings are needed.

Markets for polyethylene pipe include agricultural and rural piping (irrigation pipe, well tubing, etc.), industrial process piping, and mining and petroleum industrial applications.

## Pipe Properties

In addition to flexibility, ease of installation, and chemical inertness, the actual performance of polyethylene pipe in service is of prime importance to pipe users, manufacturers, and resin suppliers alike. Because tensile strengths and conventional instantaneous burst tests do not give values suitable for designing a pipe for long life, it has become necessary to run long-time burst tests to establish reliable design data.

### Burst Strength

Results of such a series of short-time burst tests are shown in Figure 1. Here, the test pressure is plotted vertically, and the service life experimentally observed at 113° F. is plotted horizontally. For these data we

* Based on a paper presented at the twelfth annual National Technical Conference, Society of Plastics Engineers, Inc., Cleveland, O., Jan. 19, 1956.

define the end of useful service life as the time when any hole, slit, or opening occurs in the pipe. The data shown here represent results obtainable on good extrusions. High crystallinity (high density) material has much better long-time creep strength than does low crystallinity material. Creep life was found to be essentially independent of molecular weight between melt indexes of 0.3 and 2.5.

Two vertical scales are shown in Figure 1; pressure in a one-inch standard wall pipe, and hoop stress in the pipe wall. Hoop stresses can be related to pressure in any size pipe by the standard formulas shown in Figure 2; i.e., hoop stress equals pressure times diameter divided by twice the wall thickness.

Service life is related not only to resin character, but also to service temperature and environment. Temperature effects are shown in Figure 3, where are plotted service hoop stress vs. temperature along lines of constant service life (our practical design criterion). The temperature effect is pronounced, but long service life can be expected even at 130° F. at reasonable pressures. Note, also, that for optimum strength a high crystallinity polymer is to be desired.

In addition to stress and temperature, the effect of environment on service life must be known. The chemical inertness of polyethylene is well known, and is made use of in the chemical industry where a wide variety of extremely active chemicals are packaged in polyethylene bottles. It is also known, however, that solvent-cracking agents like Igepal will seriously weaken polyethylene pipe.

Long-term burst tests aid in design by defining the effect of each agent. In Figure 4 are service life data obtained both with and without an active agent inside the test pipe. In the active environment case, a 0.01% solution of Igepal in water was used as the pressure medium in the pipe. Degradation can easily be seen.

Experiments with pipe ranging in melt index from 0.3-2.5 and in annealed density from 0.914-0.923 failed to show a substantial difference between polymers. Irradiation to levels in excess of $10^7$ rep, at a cost of 5-50¢ per pound, (1)** was needed to produce immunity to this severe environment. The effect shown in Figure 4 points out that if field failures are observed at surprisingly low service pressures, it can be suspected that improper environment was the cause.

In connection with field failures, it is important to note that small, razor-like slits are to be expected under entirely normal conditions. Occasionally a bubble may be blown in the pipe before burst, as shown in Figure 5. However, we have observed type failure to occur only with high pressures in short-time tests. The slit-type failure is characteristic of a long-term creep service failure.

## Creep Properties

Recent publications (2, 3) have mentioned that creep under pressure is a problem for polyethylene. We do not believe, however, that this is a serious limitation on design or use. Creep fracture can easily be avoided by design methods using stress rupture data of the kind found in Figures 1 and 3.

** Numbers in parentheses refer to bibliography at end of article.

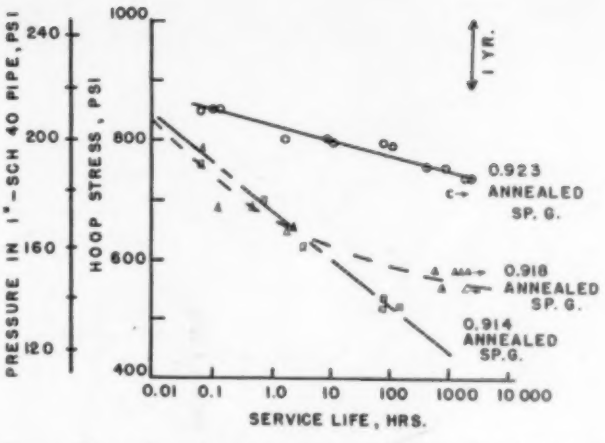


Fig. 1. Effect of service pressure on service life of polyethylene pipe at 113° F. (45° C.).

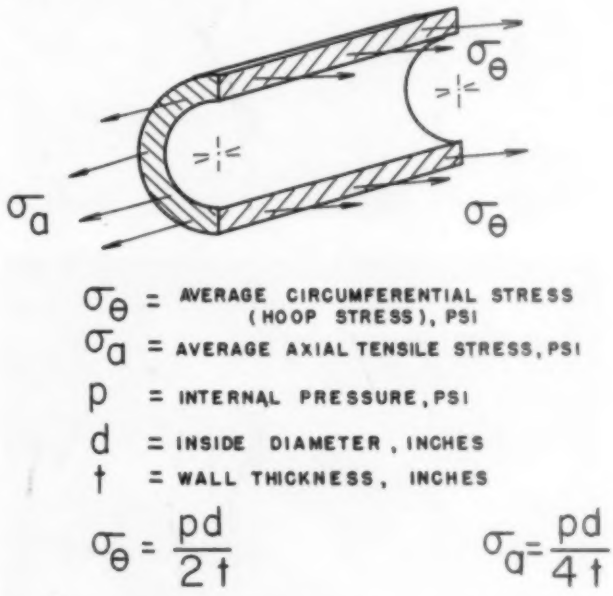


Fig. 2. Formulas for principal stresses in a closed-end tube subjected to internal pressure.

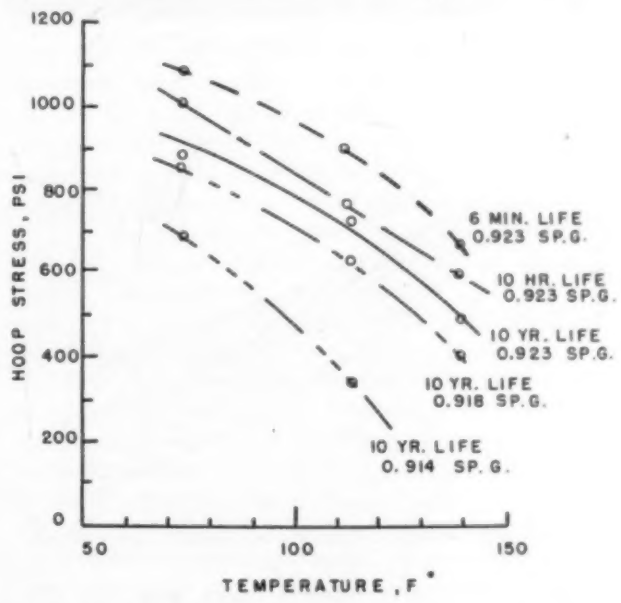


Fig. 3. Effects of temperature and pressure on service life of polyethylene pipe.

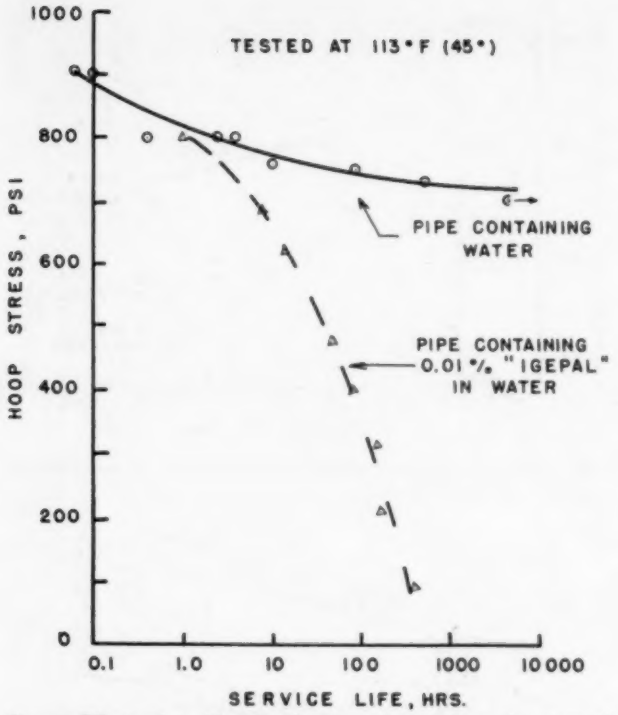


Fig. 4. Effect of a diluted solvent-crack agent on the strength of polyethylene pipe.

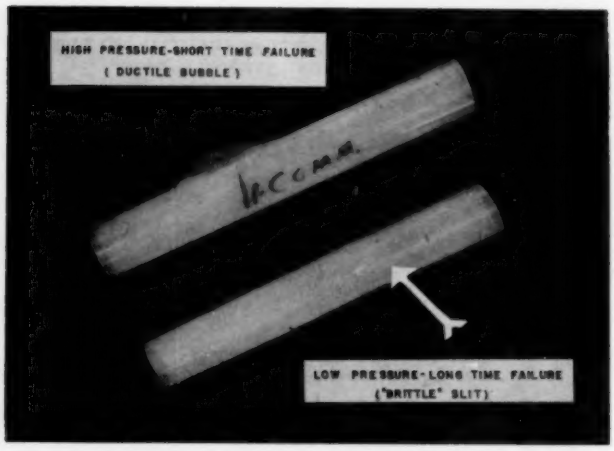


Fig. 5. Typical polyethylene pipe fractures.

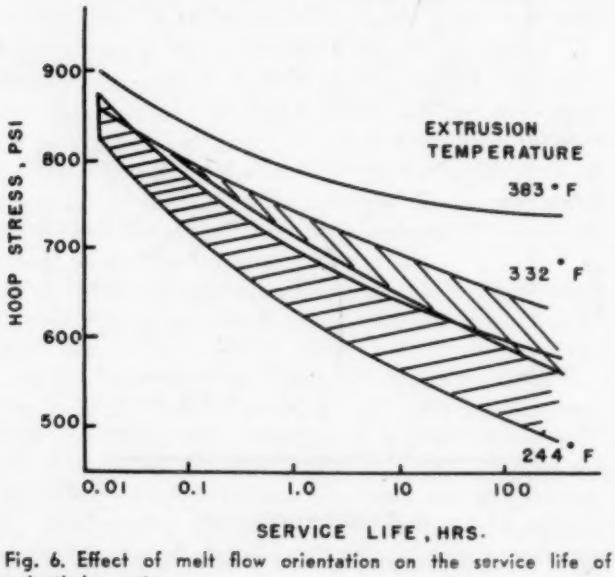


Fig. 6. Effect of melt flow orientation on the service life of polyethylene pipe.

At recommended maximum service pressures, the total diametral expansion of polyethylene pipe (instantaneous deformation plus creep deformation) in long-time creep (one year) was found to range from 5-10%. This expansion is not serious at all, in view of the general design and installation requirements for polyethylene pipe.

## Processing

A detailed description of the extrusion process for manufacturing polyethylene pipe is beyond the scope of this paper; however, one general observation can be made. Extrusion conditions should be so adjusted as to produce the maximum freedom from longitudinal melt flow orientation. Fig. 6 shows the effect of melt flow orientation on service life.

As extrusion temperature is increased (and melt viscosity is lowered), not only does long-time creep strength increase, but uniformity of strength also increases. Commercial production has been found to generally, but not always, approach the higher strengths.

## Applications

Many applications, such as chemical process and mine run-off piping, make use of the chemical resistance property of polyethylene. In the case of mine run-off piping, the previously used black iron pipe had to be replaced every three months. An installation of polyethylene pipe has now given more than two years of trouble-free service.

The chemical inertness of polyethylene has led to widespread use of film for food packaging. This inertness makes polyethylene pipe safe for conveying potable water. British standards (4) officially recognize polyethylene pipe for cold water services, and for use in chemical and food industries in Great Britain.

Ease of installation and the ability to withstand freezing have made rural markets for polyethylene pipe among the largest. In a recent conversation with representatives of the U. S. Department of Agriculture, we were told that 50% of all "headers"*** in irrigation systems in the Mississippi Valley will be flexible, mostly polyethylene, in 1956. Polyethylene pipe is used for golf course watering systems; there are 6000 courses in this country (5), and each watering system takes 3-4 miles of pipe.

One of the more interesting uses of polyethylene pipe is in skating rink cooling systems. A recent installation in Wilmington utilized 10 miles of pipe.

No discussion of polyethylene products would be complete without mention of the new, much-publicized, high-stiffness materials designated linear polyethylene, low pressure process polyethylene, etc. The general statement for other uses of these new materials is also true for pipe. These materials are so different from what we naturally think of as flexible polyethylene, that they must be considered as constituting a new plastic, with corresponding new use areas.

Specifically for pipe, the properties of the low-pressure materials are as follows:

(1) The bursting strength is high for short test times

*** the main pipelines leading from the canal to individual irrigation ditches.

(one hour or less). Based on tests of the rather limited amounts of this product available, the long-time strength may ultimately prove to be 1.5-2 times that for the best flexible polyethylene made currently.

(2) Stiffness of this new material may be expected to be around 60,000 psi., as compared with 18,000 psi. for current flexible materials. This major difference may hold back the new material where flexibility is an asset, although it could be expected that higher temperature service will be possible, and thus provide additional outlets for the high-stiffness material.

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(1) Foster, Dewey, and Gale, **Nucleonics**, 11, 10, 14 (1953).
(2) R. H. Carey, "The Mechanical Properties of Polyethylene," **SPE J.** 10, 13, 16 (March 1954).
(3) A. G. H. Dietz, "Better Buildings—With Plastics," **Modern Plastics**, 32, 6, 85 (Feb. 1955).
(4) British Standards 1972 and 1973.
(5) **Business Week**, June 25, 1955.


—The End

### Effect of Molding Technique on the Long-Time Heat Resistance of Phenolic Laminates

*(Continued from page 582)*

The "low temperature" type laminate is well suited to high-volume production at small unit price. Matched tools and presses necessary for obtaining molding pressures are expensive, but such costs dissipate rapidly when production quantities are involved. Aerodynamic surfaces of the highest order are obtainable, especially at pressures of 250 psi. and more, and close tolerances are easy to maintain.

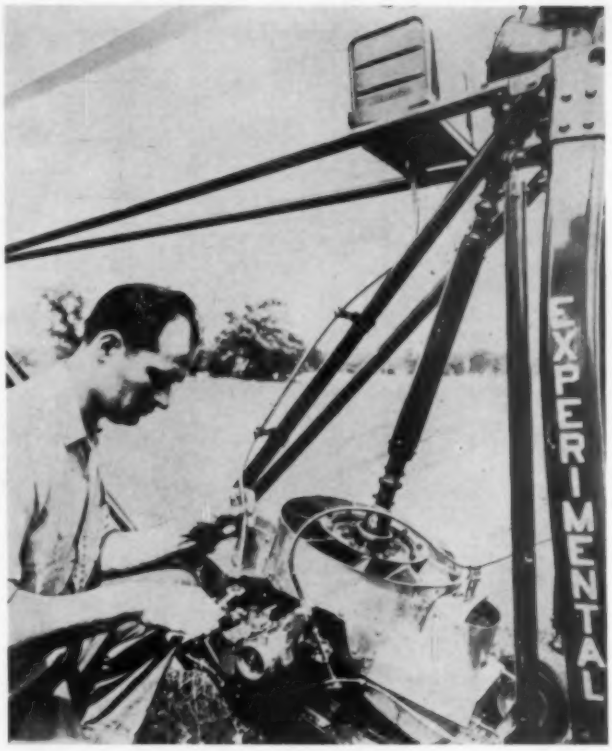
There are a few features of the "low temperature" cured phenolic which do not appeal to the aircraft manufacturer. The most serious of these is the necessary post-cure. Actually, ovens are the most inexpensive type of major equipment, and the post-curing operation requires virtually no labor. We have 11 large and medium size ovens in our laboratory, and their total purchase price would not replace one of our laminating presses.

With commercially available materials already crossing the thermal, mechanical, and psychological barriers into competition with aircraft metals, the horizons for phenolic materials in aircraft and other metal-fabricating industries seem very bright. There are many phenolic and modified-phenolic resins now under development which will provide even better heat resistance and mechanical properties. This, coupled with improvements in reinforcing materials and finishes, should serve to bring the phenolic laminate into a position as a widely used structural material. Few laminates, however, are any better than the curing process which produced them; so every effort must be made to insure that any phenolic for high-temperature structural purposes is made by a method which will deliver all of the heat resistance and strength that the resin can produce.

## Acknowledgments


The author wishes to acknowledge gratefully the assistance of E. P. Warnken and Raymond Silbernagel of C. T. L. in the preparation of this paper. He also wishes to thank D. M. Hatch, of Curtiss-Wright Corp., for permission to use references made to his work.


—The End




Close-up showing steel-jacketed fluorocarbon hose assembly.

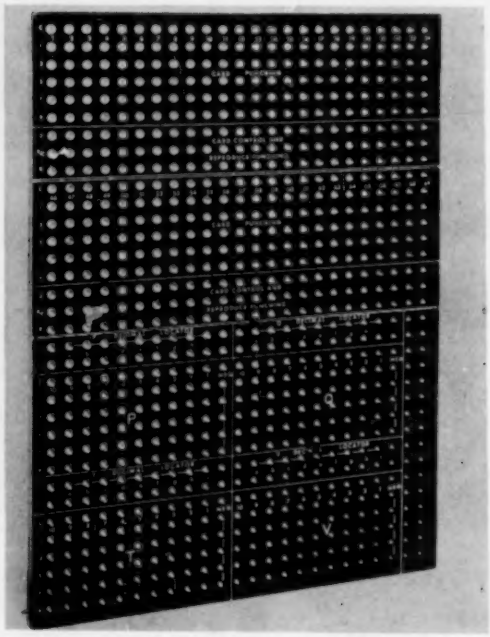
# One-Man Helicopter Employs Flourocarbon Hose Assembly

A fluorocarbon hose assembly, jacketed in stainless steel wire braid, was used by Gyrodyne Co. of America, St. James, N. Y., in developing a portable, one-man helicopter for the U. S. Marine Corps. Specifications called for a gross weight under 500 pounds, with the structural components and pilot exposed to the open air.

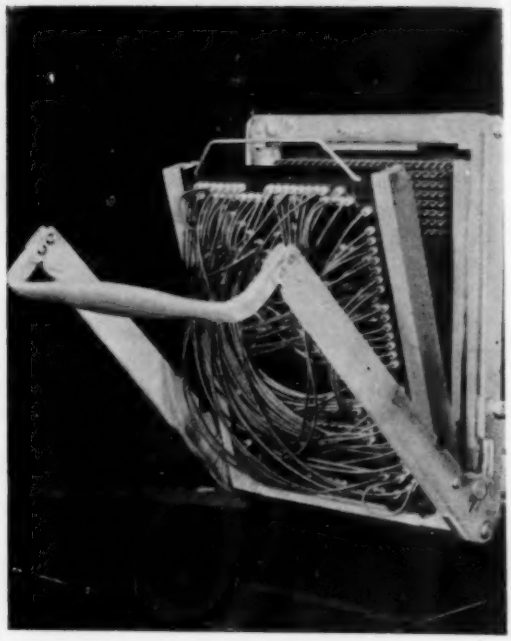
The ship's one fuel line, carrying 80-octane fuel to the two-cycle, 40-hp. engine runs exposed for about 33 inches, and is subject to considerable wear and abuse in operation and from weather extremes. Gyrodyne experimented with several fuel line constructions, and found the only satisfactory hose assembly to be that manufactured by Resistoflex Corp., Roseland, N. J.

Known as Fluoroflex-T R3800, the assembly is specially compounded and extruded from Du Pont's Teflon fluorocarbon resin. The material is completely inert to all fuels and oils, as well as being impervious to all types of weather. The steel jacket has high corrosion resistance and tensile strength, resists operational fatigue, and provides a positive blow-off proof anchor for the three-piece steel couplings.

—The End



Univac computer board molded from phenolic resin.



Aircraft-Marine's panels are easily interchangeable.

# Phenolics Permit

# Close-Tolerance Molding

Dimensional stability reportedly poses no problem in the control panels molded by Auburn Button Works, Inc., Auburn, N. Y., for the Aircraft-Marine Products Patchcord Programming System and for Remington-Rand's Univac digital computer. Hole diameters and locations can be held to close tolerances in phenolic materials, and use of the molded boards eliminates secondary drilling, milling, and finishing operations previously required with laminated phenolic sheets.

Though the two designs vary slightly, both panels measure eight by 10 inches and contain 816 holes. Female contacts are mounted permanently to a stationary panel, and removable panels serve as a plug terminal for the electrical components.

Electrical contact between two boards in the Univac computer is provided by spring jacks with patchcords which are snapped into the holes of a matching removable panel. In the Aircraft-Marine System, nylon bushing and patchcords are used in place of the spring jacks, and a removable panel slides in and up to provide positive wiping contact with stationary jacks.

Aircraft-Marine's panel was designed expressly for a molding operation since the costs of fabrication would have been prohibitive; however, Remington-Rand's boards previously had been drilled at the rate of five per hour. In addition, each stationary panel required 34 slots which were milled at the rate of approximately seven boards per hour. Dimensional stability of the phenolic was affected by temperature and humidity conditions, which made it difficult to obtain the required alignment between stationary and removable panels.

Auburn's panels were produced in a positive-type compression mold, and dimensional stability was assured by the use of a specially blended phenolic. A staggered-design heating unit promotes uniform curing and exact mold building.

—THE END

# News of the Societies

## SPE Regional Conference

SPE's Upper Midwest Section will hold a two-day "Isocyanate Symposium," October 3, at the Curtis Hotel, Minneapolis, Minn. Robert Platt, Remington Rand Univac, will serve as general chairman.

Registration fee is $3.00, and the meeting is open to all SPE members. Advance registration should be sent to Mrs. Luther Halstad, 3857 Brookview Drive, Minneapolis.

Topics and speakers are as follows: "Introduction and History of Isocyanates," R. L. Wilson, Notre Dame University; "New Surface Coatings Based on Diisocyanates," M. E. Bailey, National Aniline; "Urethane Coatings and Adhesives," George A. Hudson, Mobay Chemical Co.; "Non-Scorching Polyurethane Elastomers," J. E. Gruber, General Tire & Rubber Co.; "Effects of Foaming Catalysts on Hydrolytic Aging of Urethane Foams," Joseph Winkler, American Collo Corp.; "Effects of Toluene Diisocyanate Isomer Ratios in Polyurethane Foams," E. E. Gruber, General Tire & Rubber Co.; and "Use & Applications of Isocyanate Foams," C. Bradford Muzzy, Nopco Chemical Co.

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## TAPPI Plastics Conference

TAPPI, the Technical Association of the Pulp and Paper Industry, will hold its seventh Plastics-Paper Conference on October 3-4 at the Institute of Paper Chemistry, Appleton, Wisc.

Chairman for the October 3 session will be Paul M. Goodloe, Brown Co., and topic for the day is "Evaluation Methods of Paper-Plastic Combinations". The morning session on October 4 will be devoted to "Recent Advances in the Application of New Polymers to Paper". Chairman will be L. J. Sullivan, Lowe Paper Co. Afternoon session chairman will be W. Allan Schenck, Riegel Paper Co.; the topic is "Internal Treatment of Paper with Plastics".

Among the papers being presented are "Preliminary Investigations of Paper Laminate Properties," "Polyethylene Extrusion Coatings—Adhesion and Sealability Studies," "An Introduction to High-Density Polyethylene in Paper Coatings," "Polyacrylamide and Derivatives," "Low Molecular Weight Polyethylenes as Wax Modifiers for Paper Coatings," and "Better Adhesion of PVA to Paper".

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# NEWS of the INDUSTRY

## Carbide's Building Plans

Plans for building on its Westchester property near Tarrytown, N. Y., have been announced by Union Carbide & Carbon Corp., New York, N. Y. The company's present and future needs require the construction of certain buildings in addition to the home office building to be erected in New York City. These include an office building to house the sales staffs of several of the Corporation's divisions; a basic research laboratory to conduct general research for Carbide; and a service laboratory devoted to research work on customers' problems. These facilities will be erected on the 280-acre site in the towns of Greenburgh and Mount Pleasant.

Construction of the new buildings is expected to start early next year, with completion scheduled for early 1959. A central utilities building and a cafeteria for employees also will be constructed. When completed, the new facilities are expected to be staffed by approximately 1,000 persons. This building program in Westchester in no way affects Carbide's plans for its new home office building on Park Avenue, between 47th and 48th Streets, in New York City.

## Durite Doubles Plant Area

Durite Products, a department of Borden Co.'s chemical division, has doubled its Philadelphia, Pa. plant facilities, including both warehouse capacity and production area. Growing demands for the firm's phenolic resins and molding compounds were said to have necessitated the expansion.

## Forms Eastern Research Lab

The formation of an Eastern Research Laboratory at Framingham, Mass., has been announced by Dow Chemical Co., Midland, Mich. An important part of the company's over-all plans for expanding its research program, the new laboratory will be located initially at the Framingham facilities. The lab will be responsible for fundamental research on a long-range basis in various fields, including plastics and organic and inorganic chemicals, and will also carry on analysis and testing work.

The new lab is under the direction of Dr. F. W. McLafferty. After receiving his Ph.D. degree from Cornell University, Dr. McLafferty joined Dow's spectroscopy laboratory in Midland in 1950. He has been closely associated with the development of analytical applications of mass spectrometry and vapor phase chromatography.

## Standard Insulation Expands

An adjoining building has been acquired by Standard Insulation Co., East Rutherford, N. J., for expanding its office and warehousing facilities. Special cold-storage areas are provided for the firm's new line of Stanpreg preimpregnated materials, which are supplied to the reinforced plastic and laminating industries. Additional warehouse space will also be available for Standard's other lines, such as closure lining materials and specialty coated fabrics.

## Dominion Expands Lab Space

A major extension to the laboratory facilities is presently under construction at the Elmira, Ontario, plant of Dominion Rubber Co., Ltd.'s Naugatuck chemicals division. When completed, the project will quadruple the amount of laboratory space, and permit a more rapid expansion into new products.

New facilities will include an emulsion polymerization section for the development of high styrene resins, gum plastics, and related polymers. This section will be equipped with bottle polymerizers and complete facilities for handling butadiene and other gaseous raw materials.

Still another section will be a plastics and rubber evaluation laboratory, and will be concerned with the development of improved application methods for Vibrin polyester resins and Kralastic gums. Complete physical testing equipment will be available.

## Epoxy License Agreement

Ciba, Ltd., and Devoe & Reynolds, Co., Inc., have concluded a non-exclusive epoxy resin patent license agreement for the United States and Canada. Ciba, an international organization headquartered in Switzerland, conducts its plastics operations in the U. S. through its affiliate, Ciba Co., Inc., New York, N. Y. Devoe & Raynolds, a division of Merritt-Chapman & Scott Corp., New York, N. Y., is a leading manufacturer of paints, industrial finishes, and related products. Both companies have pioneered in the development of epoxy plastics.

## Resin Plant Producing Again

The plant in Bauer, Utah, of R-B-H Dispersions Division, Interchemical Corp., Bound Brook, N. J., is back in production of Resin 510. The plant was complete destroyed by fire last September, and h now been rebuilt to twice its former cap ity, with refinements and new safety fe tures.

Resin 510 and its new odor- and tas free version, Resin 529, are fossilized res mined in Utah. Although Resin 510 w introduced in 1947, its exact molecul structure is unknown, although it is 98 hydrocarbon with a molecular weig around 800. It is used in oleoresinous va nishes and primers, inks, rubber adhesiv and asphaltic laminants, and as an extend or modifier for alkyds, elastomers, pheno ics, waxes, vinyls, and chlorinated rubbe Resin 529 is offered to the food industry fo use in adhesives, sealants, and other com pounds.

## New Plant Nearing Completion

The large, new plant in Linden, N. J for Gomar Mfg. Co., manufacturer of pla tic laminates and metallized plastic shee ing, is nearing completion and the compan expects to move into the new quarters thi month. The new plant is the first of fou units to be built within the next three year on the 4½-acre site. When completed Gomar will have a total of 100,000 squa feet of air-conditioned floor space, and wi employ 75-100 persons.

## Announces Synthetic Fiber

A new synthetic textile fiber, said t combine the ease-of-care properties o other synthetic fibers with the exceptional versatile dyeing characteristics of cellu losic fibers, has been introduced by Dow Chemical Co., Midland, Mich. Called Zefran, the fiber is chemically a nitril alloy.

Other characteristics reported for Zefra are good initial whiteness, bleachability wear resistance, freedom from pilling ten dencies, resistance to rot and chemicals and dimensional stability when exposed to elevated temperatures. Suggested applica tions cover most classes of textile good including work clothes, play clothes, suit ings, draperies, upholstery material, and heavy industrial fabrics.

Research and pilot plant operations have been conducted at Dow's Pittsburg, Calif. plant and at the Midland headquarters. Construction is presently under way on a plant near Lee Hall, Va., which will be devoted exclusively to manufacture of the fiber. Completion is scheduled for Fall of 1957.

## American Air Filter Expands

A 60,000-square foot expansion of it Famco, Inc., plant in Louisville, Ky., has been announced by American Air Filter Co., Inc. Construction will begin immedi ately, with occupancy scheduled for next May. The new structure will be used pri marily for warehousing such Famco-made products as glass fiber mats, filters, and filter media. Other space will be reserved for additional glass-spinning machines.

# ERIE PRESS OF THE MONTH

## 800-TON HOT PLATEN PRESS

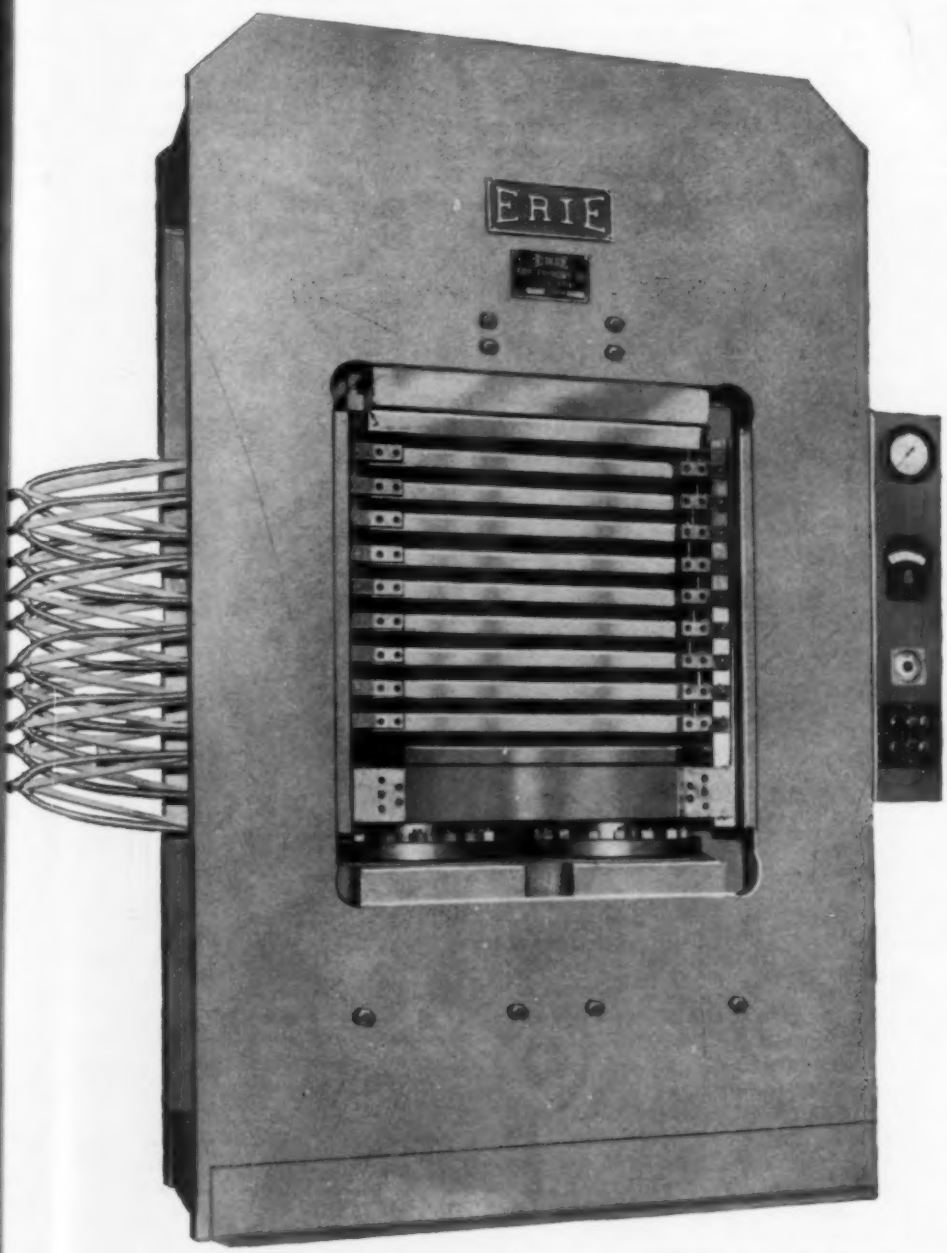
This Erie Foundry hot platen press is designed and built for precision molding. It is compact and rigid, with minimum deflection . . . yet of economical design.

The press is self-contained, with push button control for semi-automatic or manual operation. Platen guides are arranged to provide accurate alignment over the entire range of platen temperatures.

To prevent scoring of the ram, the inserted cylinders are furnished with bronze bushings in gland and stuffing box.

At present, this 10-platen press is being used in the production of printed circuits. It is equally adaptable wherever multiple-opening heated platen presses are required.

For additional information on this press or on the complete line of Erie Foundry rubber and plastic hydraulic presses, just write to: Erie Foundry Company, Erie 6, Pennsylvania.




800-TON
HOT PLATEN PRESS
2 rams 15½" dia. each
Platen size 42" x 24"
10 openings 2" each
Stroke 20"

ERIE

SINCE 1895

*Hydraulic Press Division*

**ERIE FOUNDRY CO.** ERIE, PA.

## Roberts Establishes New Plant

A new factory at 7349 Coldwater Canyon Ave., North Hollywood, Calif., has been set up by Ned L. Roberts for the manufacture of vacuum forming equipment and industrial radiant heaters. An improved-type Nichrome Fiberglas heater is being manufactured, which is said to eliminate some of the operating difficulties previously encountered with this type of heater. The latest vacuum forming and skin packaging equipment are available for on-the-spot demonstration at process plants.

## Borden Acquires Pioneer Latex

The entire holdings of Pioneer Latex & Chemical Co., Middlesex, N. J., have been purchased by Borden Co., New York, N. Y., for merger with its Resinous-Reslac department. An undisclosed amount of stock was exchanged for Pioneer's assets, which include the Middlesex plant and interests in Placco, Puerto Rico and Placco, Columbiana, Ltd.

The merged units will be known as Resinous-Reslac-Pioneer. Since Pioneer also manufactured protective coatings, flooring, and adhesives, the move enables Borden to offer a more diversified line. Stephen G. Paliska, president of Pioneer since its inception, will become assistant general manager of the merged department. Ashworth N. Stull continues as general manager.

## Killion to Build Extruders

A tool and die manufacturer with over eight years experience in the manufacture of extruder screws and custom-designed extruders, Killion Tool & Mfg. Co., Verona, N. J., has entered the extruder-building field. The firm is presently offering a 2½-inch demonstrator machine, and is engaged in building a 1½-inch laboratory model and a 4½-inch extended barrel machine. Along with these machines, Killion supplies conveyors, pelletizers, and other custom equipment. The company has been established approximately 15 years, is individually owned, and occupies a plant with 15,000 square feet of floor space.

## Schedules Anglo-U.S. Plant

A $11-million Perspex plant will be constructed in Louisiana, Mo., as a joint project of Imperial Chemical Industries, Ltd., London, England, and Hercules Powder Co., Wilmington, Del. The facility will occupy a 20-acre site adjoining the Missouri Ammonia Works, and will have an annual capacity of 34 million pounds of methyl methacrylate. Both monomers and polymers will be produced.

I. C. I. pioneered the process used throughout the world for the synthesis of methyl methacrylate monomer, and trademarked the name Perspex for polymethyl methacrylate sheet. To the joint project, the British group brings its production, research, and technical sales service experience; while Hercules will provide a technical organization experienced in U. S. production methods, an established position in domestic markets, and the advantages of a site where the basic raw materials are readily available.

Ammonia and methanol are produced at the Missouri plant, and natural gas is available in unlimited quantities from an adjacent pipeline to Texas gas fields. Hercules produces a fourth raw material, acetone, at its plant in Gibbstown, N. J.

## Announces Expansion Program

A multi-million dollar expansion, which will increase the output of the world's largest butadiene plant in Port Neches, Tex., by 50%, has been announced by tis joint owners, The Texas Co., and United States Rubber Co. Anticipated production will be 300,000 short tons annually, a figure which should be reached by Fall of 1958.

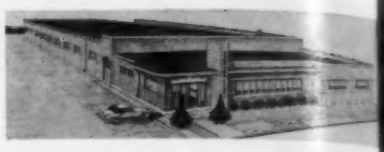
In addition to being one of the principal ingredients of butadiene-styrene type synthetic rubbers, butadiene also is used in several types of plastics. Once the existing shortage has been relieved, the Port Neches plant will investigate new synthetic polymers and petrochemical products.

## Dow Administration Center

Plans to build a new administrative center in Midland, Mich., have been announced by Dow Chemical Co. In its final form, the center will be a group of buildings in an area one-half mile long and one-quarter mile wide containing headquarters for the entire company. The site is an 80-acre tract at the northwest intersection of Saginaw Road and Bay City Road. The master plan for the center calls for construction of the first three units as soon as plans have been finalized and bids taken.

The first unit to be built is the chemical sales and technical service building which is expected to be completed late next year. The next units to be built are an executive office building, which will be the heart of the center, and a plastics building. Other units will be added as needed over a period of several years, and the center will be of an expansible design to permit the addition of new wings and buildings at a later date as they are needed.

The executive office building will house the company officers, staff departments, general services, and cafeteria. The plastics building will be headquarters for the plastics management and staff, plastics sales, coatings technical service, plastics technical service, and related groups. The chemical sales and technical service building will house the general chemicals management, the various chemical sales, technical service, and development departments, the company's traffic department, and related service groups.



Architect's sketch of new Thermel facili

## New Quarters for Thermel

Thermel, Inc., manufacturers of elec cal heating units, has moved to a new f tory and offices at 9400 Robinson R Franklin Park, Ill. (a suburb of Chicag The new structure has more than 10,0 square feet of floor space to accommod the firm's expected increases in producti Thermel production has increased m than 400% in the past three years a result of the adoption of its heating u on many plastics extruders and formi machines.

## Tile Company Expands

The construction of an addition to plant that will more than double its prese production facilities has been announc by Lustro Tile Products Corp., Akron, The new building, a modern brick str ture, will be erected behind the firm's pr ent factory. Installation of the most mode equipment in the additional space will e able Lustro to increase production by least 65%. The work force will be i creased by at least one-third to operate t new machines. The new equipment. w consist of injection molding machines a extrusion machines for the manufacture o plastic wall tiles.

## Plasti-Fab Opens New Factory

Pacific Plasti-Fab Corp., has moved int a newly enlarged plant and administrati offices at 1001 Varian St., San Carlo Calif. This represents the fourth such e pansion since World War II.

The new facility doubles the firm's pr duction area, and will house an assembl line for manufacturing illuminated outdoo signs. Pacific fabricates sheet thermopla tics, vacuum forming them into small coun ter displays and 40-foot illuminated panel

## 3M Purchases Zenith Plastics

Zenith Plastics Co., Los Angeles, Calif. producer of specialized plastic component for aircraft, has been purchased by Min nesota Mining & Manufacturing Co., St Paul, Minn., for $4,000,000. The purchase was said to provide tremendous mutual benefits without altering Zenith's manage ment or policies. 3M's financial backing and research team will enable Zenith to realize its full potential.

Details of the transaction give 3M con trol of substantially all of Zenith's assets and the purchase price will be met with cash and 3M common stock. Zenith will operate as a wholly-owned subsidiary, with Milton Brucker continuing as its president. H. J. Tierney, 3M vice president in charge

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of reinforced plastics, will serve as liaison officer between the parent company and its new subsidiary, and a small 3M team will provide consulting services on management and operating problems.

## Expands Customer Service Lab

The design and construction contract for a two-story addition to Shell Chemical Corp.'s customer service laboratory in Union, N. J., has been awarded to Walter Kidde Constructors, Inc. Scheduled for completion next April, the new building will contain 26,000 square feet of space for laboratories and offices.

A special design feature is the double-wall separation between inter-laboratory corridors. This will provide space for ductwork, piping, and other service facilities, at the same time making additional space available for test apparatus. Construction will be reinforced concrete, with slag-finished slab roof. Exterior walls will be concrete block, with brick facing. All interior walls will be of structural glazed tile, and the floors will be covered with vinyl and rubber tile. Chemical solvents will be stored in a small, separate building.

The new addition will be completely air conditioned, and all services will be individually-tailored to the various test processes. Projects will be largely restricted to end-use testings involving Epon, Shell epoxy resin.

## Doubles Production Capacity

The first major expansion in floor covering production has been announced by General Tire & Rubber Co.'s recently created flooring division at Jeanette, Pa., coincident with the introduction of the firm's Terrazzo vinyl tile. Manufacturing capacity will be doubled to meet the demand for Bolta-Floor, as well as anticipated sales of the new product. Reputedly the world's largest producer of plastic film and sheeting, General's plastics division topped $70-million in sales over the past fiscal year.

## Adding to Tech Service Lab

Ground was broken on June 25 by Shell Chemical Corp., New York, N. Y., for a two-story addition to its technical service laboratory in Union, N. J. The new building will contain approximately 25,000 square feet of lab and office space. The expansion will provide space needed to increase the company's technical service work in plastics and resins, solvents, industrial chemicals, and agricultural chemicals. Construction of the new facility is expected to be completed in April 1957.

## Owens-Corning Expands Plant

A major expansion of its Anderson, S. C., plant has been announced by Owens-Corning Fiberglas Corp., Toledo, O. Scheduled for completion by mid-1957, the new facilities will increase the plant's output by 50%.

Included in the plans are additions to the existing fabricating and warehousing areas, an automatic plant for storing and mixing raw glass materials, and equipment for all types of processing and fabricating. The company has recently completed an expansion at its textile products plant in Huntingdon, Pa., and has an improvement program underway at Ashton, R. I.

## Michigan Chrome Buys Pyramid

Michigan Chrome & Chemical Co., Detroit, Mich., manufacturer of vinyl plastisols and industrialized coatings has acquired the assets of Pyramid Plastics Co., Chicago, Ill. The move gives the Michigan firm the facilities of an established, specialized industrial extruder.

The Chicago operation will continue as Pyramid Plastics, and will be expanded to manufacture and warehouse Michigan Chrome's line of Miccro products. Also announced, was the formation of Michigan Chrome & Chemical Ontario, Ltd., for manufacture and distribution in Canada.

(*Continued on page 624*)


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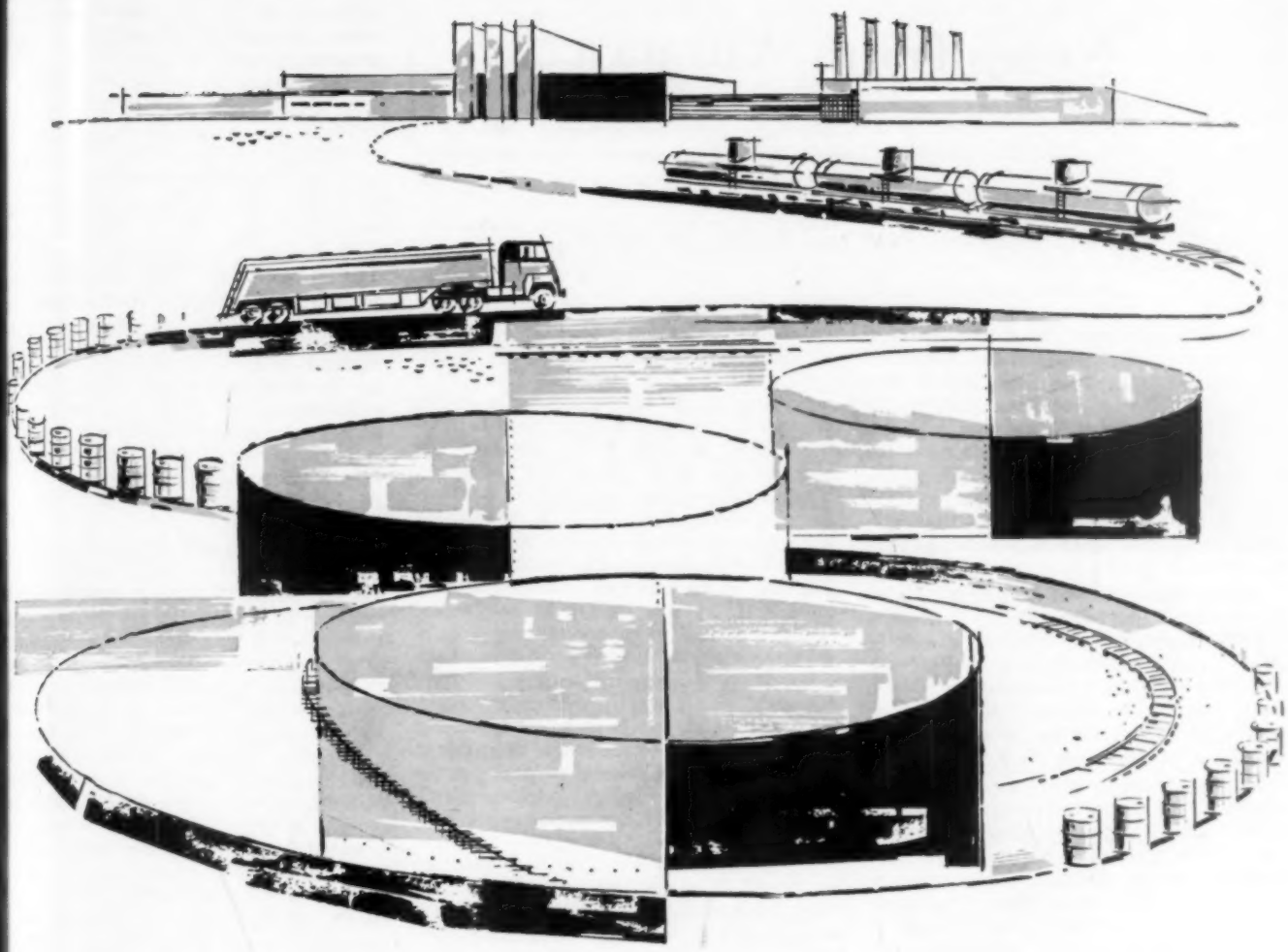

# Now! Large Phenol, U.S.P. storage facilities near principal consuming points

To better serve Eastern and Midwestern Phenol users, Oronite has established bulk distribution terminals at key consuming points. This means large quantities of Phenol, U.S.P. in tank car, tank truck and drum shipments are quickly available from Oronite.

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# News from Abroad

## PVC Progress, Past and Future, in Japan

Japan first learned about PVC in 1939 when the German product, Igelit, was introduced there, arousing such interest that research on the material was immediately started. By 1941, the Nihon Chisso Hiriyo was able to put its own product on the market. The Yokohama Rubber Co., Ltd., had already started to use imported PVC around 1940 and, about the same time, two other companies began to experiment with it.

Acute shortages of asbestos during World War II led Nihon Chisso to develop a PVC fiber to replace asbestos in making diaphragms for electrolytic cells. By 1944, this fiber was being produced on a relatively large scale, much of it also going into work clothes for use in plants at the war front, in the South Pacific.

Real progress, however, was not made until after the war, when producers learned about recent foreign developments. A number of new companies began to test these methods and by 1949, 20 firms were engaged with PVC, producing 200 metric tons. Many of these firms were deficient in experience, finance, and equipment, the inefficient companies were shaken out at the same time that the industry went forward rapidly with quality and quantity.

Now, PVC is produced by 11 companies, including Japan Geon (affiliated with the Yokohama Rubber Co.); Kanegafuchi Chemical & Industrial Co.; Shin Nippon Chisso Hiriyo; Monsanto-Kasei Chemical Co.; Sumitomo Chemical Co.; and Mitsui Chemical Co. There was a similar shakeout of PVC processors, and at present only 10 large companies remain whose products include supported and unsupported sheet, film for a variety of purposes, rigid and non-rigid sheet, extrusions, PVC coatings for wire and other purposes, paint, plastisols, and organosols.

Most of the PVC goes into film, and a good deal is used in coatings for wires. In the last few years, there has been increasing interest in rigid PVC, especially for pipe for conveying water and chemicals. This year, some firms adopted the vacuum-forming process for making advertising signs and various decorations. A good deal of PVC film is used in agriculture, and recently, its use has been extended to sericulture. It is also used over salt fields, where it is said to be contributing greatly to increased salt production. In the fisheries, floats of rigid vinyl sponge and fishing nets of filaments are popular. Rigid PVC sheet finds use in chemical apparatus and also in furniture. Japanese department stores feature a wide range of locally-made PVC hand bags, luggage, briefcases, and shoes and sandals for young girls and children.

Japan Industrial Standards have been set up for PVC manufacturers, and specifications have been published for agricultural film, insulated wire and cord, insulation tubes and tape, rigid PVC pipe, cable sheathing, water pipe, and non-rigid tubing.

The Japanese Ministry of International Trade and Industry has set up a five-year schedule for the production of PVC and other plastics materials. Outputs, in metric tons, in 1955 and the targets for the years 1956-1960 inclusive are shown in table.

Arrangements are reportedly well under way for erection of three new plants, one for PVC and two for polyethylene. The Nishin Chemical Co. is completing a plant at Takaoka, with initial annual capacity at about 5,000 tons of PVC. This is understood to be a joint venture of three Japanese Chemical companies. Mitsui Chemical Co. is to produce polyethyl by the Ziegler process in a plant u construction at Iwakuni which may ready to open by the end of 1957. S tomo Chemical Co. is working on a p ethylene project in association with perial Chemical Industries at Yokaishi.

5-Year Production Schedule for Plastics in Japan.

| | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 |
|---|---|---|---|---|---|---|
| Phenolics | 12,000 | 13,400 | 14,000 | 15,000 | 16,000 | 16,500 |
| Urea | 42,400 | 50,000 | 53,000 | 56,000 | 60,000 | 65,000 |
| PVC | 36,000 | 55,000 | 60,000 | 65,000 | 70,000 | 72,000 |
| Acrylics | 700 | 1,200 | 1,500 | 2,000 | 2,500 | 3,000 |
| Silicones | 190 | 300 | 400 | 500 | 600 | 700 |
| Fluorides | 14 | 200 | 300 | 400 | 500 | 600 |
| Alkyd resins | 6,000 | 6,200 | 6,600 | 7,300 | 8,000 | 8,500 |
| Polyesters | 400 | 1,000 | 1,500 | 2,000 | 3,000 | 3,500 |
| Polystyrene | — | 1,100 | 6,300 | 8,000 | 10,000 | 12,000 |
| Polyethylene | — | — | 10,000 | 15,000 | 20,000 | 25,000 |
| Acetates | 1,540 | 2,100 | 5,000 | 6,000 | 6,400 | 7,000 |
| Totals | 99,844 | 131,500 | 158,600 | 177,200 | 197,000 | 213,800 |

## Tenth Anniversary of Dutch Plastics Research Institute

In September, the Plastics Research stitute T.N.O., Delft, Holland, is celeb ing its tenth anniversary. Since its offi establishment in 1946, the Institute undergone continuous and rapid expansi and now is one of the largest departme of the Central National Council for A plied Scientific Research in the Neth lands.

From its start with a staff of 10 pers the Institute now employs nearly 180 p ple plus about 55 persons engaged in b research in high polymers in the Cen Laboratory T.N.O. Most of the activi of the Institute are directed primarily to Dutch plastic industry, whom it serves a center of information, as a consultati body, and occasionally as an extension its research facilities. For ultimate perf mance of these tasks, an intensive cont with foreign manufacturers and organi tions is of great importance.

Ranking first among the departments the Institute is the technological dep ment which carries out research for b itself and the industry. Linked to t activity is a newly established reinfor plastics pilot plant. Another import group is the information and documen tion department which gathers and d seminates information on plastics proce ing, applications, and availability; edits periodical "Plastica"; and organizes cours plant tours, and lectures on plasti Finally, there is the testing and analyti department which has a major role in w on standardization of plastic products.

## Plastics in Dominica

According to an American Embassy port, the Dominican Republic neither m ufactures its own plastics materials n fabricates semi-finished forms of plast into finished products. Consumption limited to finished products, most of wh are used in construction and imported fr the United States. These include acry sheets, corrugated plastic roofing, electri parts, and water conduits. Except for a fe small shops making Formica and oth laminated plastic tops for tables and fu niture, there is no enterprise in the plast fabricating industry.

The major deterrent to plastics consum tion and fabricating is the high duties plastics, amounting to 15¢ per kilogra

2046 pounds) for unworked plastic materials and $1 per kilogram for most finished plastic products. The only items in the unworked category being imported in any significant volume are the flat acrylic sheets. Except for the laminated plastics (for table tops) which are not classified as plastics for customs purposes, all others are assessed at the higher rate. In addition to these duties, merchandise is subject to a 23% so-called "unified" tax, a 3% tax for consular charges, and various other charges amounting to about 4%.

Most plastic products consumed are imported from the U. S. because they can be bought and shipped in more rapidly than from Europe. In quality or utility, however, there is no preference for U. S. plastics products.

## Netherlands Plastics, 1955

The Netherlands plastics industry continued to advance in 1955, but at a somewhat slower pace than in the preceding year. Total sales of plastics at home and abroad came to 25,662 tons last year, as against 21,646 tons in 1954 and 11,366 tons in 1950. Polycondensation and polyaddition products accounted for 18,089 metric tons, or about 70% of the 1955 total and almost double the 1950 total. Polymerization products have been developing at a more rapid rate than the other plastics and at 4,867 metric tons, were about seven times higher than in 1950. The figure for cellulose and protein plastics was 2,706 tons in 1955.

Both imports and exports have mounted. In 1950, total imports were 7,796 metric tons; in 1954, the total was 18,555; and in 1955, there were 25,634 metric tons. Similarly, exports which amounted to 3,738 tons in 1950, rose to 13,754 tons in 1954, and again to 16,898 tons last year.

## Plastics in South Africa

Corvic and Welvic PVC compounds, products of I.C.I., are to be manufactured in a new factory built by the African Explosives and Chemical Industries, Ltd., near Durban, Natal. This will be the first time PVC is produced in South Africa. It is planned to make four grades of Corvic materials: an emulsion type for cable sheaths, calendered sheets, floor tiles, etc.; two granular grades, one for cable insulation and the other for products which must have good surface finish and color, or where crystal clear extrusions are required; and a preparation for making fabric coatings. In addition, Welvic compounds in chip form in different colors and grades will be put on the market and prepared to special requirements, if desired.

South African manufacturers, particularly in the Johannesburg area, also are displaying activity in the manufacture of new types of plastic goods. A recently established firm in Johannesburg makes a preparation for covering floors and walls. This consists of a mixture of silicate and a resin, and is claimed to give surfaces in a variety of colors, any desired pattern, oil- or acid-proof, hard or soft, and non-skid. Surfaces are claimed to be non-porous, resilient, and easy to clean.

Another Johannesburg firm is making fittings for electric ranges from polyester resins, and is one of the first South African firms to take up this line. A third firm in the area is producing nylon monofilament fishing lines, strings for tennis rackets, and various other applications of nylon monofilaments in sports and industry. Polyethylene piping from 2-10 inches in diameter is also being made in South Africa by a company associated with an English firm.

Other plastics goods now being marketed by local manufacturers include colored plastic table mats, fly swatters, soap dishes, toys, sink strainers, and rainwear of canvas- and cotton-supported plastic.

## Chemical Sciences Convention

The Convention of Chemical Sciences, 1956, which will be held in Paris, France, on November 24 to December 3, at the same time as the Fourth Chemical, Rubber and Plastics Exhibition, will include several important meetings. The 29th International Congress of Industrial Chemistry will hold sessions of its 21 sections every morning from November 18-20. In the afternoons of this same period, there will be meetings of the First Congress of the European Corrosion Federation, whose work is divided into eight sections. The Eleventh European Conference of Chemical Engineering will be held November 22-24, and will include three symposiums: Calculations of Converters; Calculations of Reactors; and Extraction by Solid Adsorbents.

The Parisian Technical Days will include a series of specialized symposiums on Plastics; Rubber, Measurements; Control and Regulation; Analysis and Tests; High Grade and Special Steels; and Polar and Tropical Equipment. A question of immediate interest will be discussed each day during the meetings on November 26-30 and December 3.

The Fourth Chemical, Rubber and Plastics Exhibition, arranged for November 22 to December 3, is to have seven sections: Laboratory Equipment; Engineering and General Equipment; Special Apparatus; Raw Materials and Industrial Products; Natural and Synthetic Rubber Industries; Plastics Industries; Organization.

## Aminoplastic and Phenolic Moldings in the Tropics

The results of tests carried out on aminoplastics and phenolics at the Tropical Testing Establishment of the Ministry of Supply at Port Harcourt, Nigeria, have recently been reported. In the tests, arranged by a Joint Service/British Plastics Federation Joint Sub-Committee, molded disks of five aminoplastic molding materials and 12 phenolics were exposed to the moist and warm conditions in jungle undergrowth, jungle clearing, and base depot of the Port Harcourt area, as well as to semi-desert conditions of Kano where the days are intensely hot and sunny, the nights relatively cold, and humidity is low.

All samples exposed out of doors lost initial surface gloss, became discolored, and showed weathering at the jungle clearing and semi-desert sites. Most samples showed biological growths at the jungle clearing throughout the trial. While corrosion was noted on the brass inserts of all specimens exposed to the open, there was no deleterious effect on the plastic materials, and the inserts did not seem to corrode more in one batch of samples than in others. Some samples, including the controls, warped at all sites.

Of the aminoplastics, the worst was Specimen "U", a urea resin with woodflour filler, while the least change in appearance was noted on Specimen "D5" (aniline-formaldehyde molded resin, Panilax), "Ux", and "D1" (urea and melamine resins, respectively, each with alpha-cellulose filler), "D5" showed no warping throughout the exposure.

Of the phenolics, the worst in this test, was No. 8 (one of two nylon-filled phenolics). No. 10 (woodflour-filled) showed the least change in appearance, while Nos. 5 and 6 (asbestos and mica filled, respectively) showed no warping throughout exposure. Weathering seemed an inherent defect of No. 3 (woodflour and ground cellulose fiber filler) and No. 4 (cotton rag filler).

Under humid conditions, all samples increased in weight and dimension, but decreases were shown by the samples in the semi-desert at Kano. Impact resistance of all specimens improved at the dry site during the first part of the trial, but all decreased at the end. Of the aminoplastics, "U" was the least favorable; it underwent the greatest change at all sites and showed the greatest loss in impact strength. "D5" changed the least, while "D1" and "D2" (melamine resins with alpha-cellulose and asbestos plus small proportion of cotton, respectively) best retained their impact strength. Of the phenolics, Nos. 6 (mica filler) and 9 (modified, with mica filler) changed the least in weight and dimension, but both were among the five phenolics showing greatest loss of impact strength. Two woodflour-filled phenolics showed the smallest loss of impact strength.

As to electrical properties, volume and surface resistivity decreased at the humid site and increased slightly at the semi-desert site. These effects were reversed for power factor and conductivity. Electrical stability was good for all the aminoplastics, except for "U" (the urea resin-woodflour sample). Among the phenolics, No. 8, one of two nylon-filled phenolics, showed greatest electrical stability.

# NAMES in the NEWS

Dr. William L. Evers

**William L. Evers** has been named assistant manager of fiber research for Celanese Corp. of America, New York, N. Y. In this capacity, his primary responsibility will be for fiber polymer research in the firm's Summit, N. J., research labs. Since joining the company in 1951, Dr. Evers had served successively as assistant manager in charge of research for the plastics division, and on the staff of the central development department.

**Ben W. Rau** has been elected president and treasurer of G. Felsenthal & Sons, Inc., a Chicago plastic processing company. Other new officers are **N. C. Ratner,** vice president; **James H. Moses,** vice president; and **James G. Felsenthal,** corporate secretary.

**Nelce C. Taylor** has been named West Coast plastics service engineer for Eastman Chemical Products, Inc., Kingsport, Tenn. He has been with Eastman since 1937, serving in various engineering and sales posts. He will work out of the Los Angeles, Calif., office of Wilson & Geo. Meyer & Co., Pacific Coast sales representatives for Eastman Chemical.

**A. N. Wohlwend** has been appointed director of commercial development for Escambia Bay Chemical Corp., with offices at 261 Madison Ave., New York City. He previously served in the same capacity with Stauffer Chemical Co.

**Howard K. Nason** has been appointed general manager of Monsanto Chemical Co.'s research & engineering division, St. Louis, Mo. He formerly served as director of research & development for the organic chemicals division. **N. N. T. Samaras,** assistant general manager of the research & engineering division, has been given a special assignment with Monsanto's executive committee.

**A. E. New** has been appointed director of the technical department in the manufacturing division of Escambia Bay Chemical Corp., Pensacola, Fla. Holder of an M.S. degree in chemical engineering, Mr. New formerly served as director of process development at the Texas City plant of Carbide & Carbon Chemicals Co. In his new position, he will be responsible for process design and engineering projects, from pilot plants through full-scale plant operations.

**Charles J. Bahun** and **K. U. Patel** have joined the Philadelphia laboratory staff, Durite Products department of Borden Co.'s chemical division. Mr. Bahun will serve as group leader in charge of molding material development, and Dr. Patel as chemical engineer with the development staff.

**Clinton F. Hegg,** vice president of L.O.F. Glass Fibers Co., Toledo, O., has been named general sales manager for the firm. He will direct sales activities in the automotive, textile mat, and general products divisions.

John H. Woodruff

**John H. Woodruff** has been elected president of Auburn Button Works, Inc., Auburn, N. Y., succeeding E. Brewster Crawford. Mr. Woodruff was previously vice president. He is a member of PLASTICS TECHNOLOGY'S Editorial Advisory Board. Other officers elected at the same time were **Merton R. Turrell** as vice president, and **Lester R. Lessig** as secretary and a director of the company.

**George C. Arnold** has been appointed field representative, Boston area, for L. O. F Glass Fibers Co., Toledo, O. He replaces **George R. Frick,** who was recently named sales manager for the Syracuse district.

William L. Niclaus

**William L. Niclaus** has been reelect president and chairman of the board f Wilpet Tool & Mfg. Co., Kearny, N. custom and proprietary injection molde He was formerly a partner in the pred cessor company, Wilpet Engineering Mfg. Co.

**Robert E. Lenz** has been appointed sistant director of the chemical resear department, research & engineering di sion of Monsanto Chemical Co., St. Lou Mo. He will be headquartered at Dayto O., where he will direct the engineeri research section of the department. Wi Monsanto since 1940, **Mr. Lenz** has he various chemical and engineering pos serving as special project manager sin 1954.

**William J. Dewar** has joined Furan Plastics, Inc., Los Angeles, Calif., as pro uct engineer. He has served as technic director of the Plastics Institute, and h been associated with Flexfirm Produc and Standard Plastics.

**Francis H. Bebee** has been appointe manager of Interchemical Corp.'s newly created commercial development depar ment, New York, N. Y. The new depar ment's responsibilities will include produc development and project commercializa tion. Mr. Bebee formerly served as a sistant to the president, textile colo division.

**Richard Voelz** has joined Hull-Standar Corp. as sales engineer in the Wisconsi Illinois, and Indiana territory. He wa previously associated with F. J. Stokes Ma chine Co. and Fisher & Porter Co.

**William D. Lippmann** has been name administrative assistant, and **William T Siebenthal** production manager of Genera Tire & Rubber Co.'s Textileather division Toledo, O. Mr. Lippmann formerly serve as division superintendent of coated fab rics, while Mr. Siebenthal was productio manager of North Star Woolen Mill Co

General Electric Co.'s silicone product department, Waterford, N. Y., has an nounced the following four appointment

in its engineering section:
**Stuart D. Brewer** as manager of resin product engineering.
**Frederick M. Lewis** as manager of advance development.
**Abbott Pozefsky** as manager of the analytical and control methods unit.
**William F. Gilliam** as specialist, technical information exchange.

**John L. Burnie** has been named polystyrene sales manager for Monsanto Canada, Ltd., and will make his headquarters in Toronto, Ont. He has been serving the firm as sales and technical service representative since 1939.

**Lawrence D. Bragg** has been named acting general manager for General Tire & Rubber Co.'s Respro division, Cranston, R. I. He succeeds **R. S. Newell,** who has purchased Respro's United Lace & Braid section which he will operate independently.

**Gino R. Treves, John A. Gannon, Murray H. Reich,** and **Charles deThan,** research chemists, have been appointed to the staff of Food Machinery & Chemical Corp.'s research laboratory at Princeton, N. J. Dr. Treves joins the organic chemistry department; Mr. Gannon and Mr. Reich, the polymerization section; and Mr. deThan, the polymer evaluation section.

Koppers Co., Inc., Pittsburgh, Pa., has announced the following personnel appointments to its newly-established plastics applications department:
**W. J. Fitzgerald** as section manager.
**D. H. Blair** as representative in western New York, Pennsylvania, Ohio, eastern Michigan, and Kentucky.
**V. O. Reising** as representative in the Midwest.
**Lacy Seabrook** as consultant along the Eastern seaboard.

**Wilbur V. Keegan** has joined Carbon Dispersions, Inc., Newark, N. J., as stockholder and vice president. He will engage in technical development and in sales. Mr. Keegan brings over 15 years experience in the field to the Newark firm.

**Michael Pisetzner** has been elected vice president and general manager of American Molding Powder & Chemical Corp., and of A. Bamberger Corp. **Herbert H. Goldmark** continues as vice president and general sales manager. **Roy A. Sorenson** was named production manager. Mr. Pisetzner was formerly research and development chief for Ansbacher-Siegle Corp., and Mr. Sorenson formerly served as chief chemist and assistant general manager of Nixon Nitration Works.

**W. L. Vega** has been appointed manager of American Plastics Corp.'s newly-formed special products division. He formerly served as manager of Celluplastic Corp.'s pharmaceutical division, and as sales manager of U. S. Fiber & Plastics Corp.

**Karl Ellingson** has been appointed general manufacturing superintendent of Monsanto Chemical Co.'s John F. Queeny plant, St. Louis, Mo. Previously manager of the Norfolk, Va. plant, he succeeds **J. William McCrackin** who has joined Mobay Chemical Co., as a technical service representative.

**Plax Corp.,** Hartford, Conn., has announced the following promotions: **Grant S. Brown,** former assistant manager, to manager of research; and **Robert G. Strauss** and **Richard J. Morcom** as assistant research managers. Mr. Strauss will be responsible for blownware engineering, while Mr. Morcom will be in charge of extrusion engineering. The three men have been with Plax since 1954, 1951, and 1953, respectively.

H. Alfred Rack

Bernhard W. Weber

**Bernhard W. Weber** has been appointed manager of manufacturing for Metal & Thermit Corp., New York, N. Y. **H. Alfred Rack** will take over Mr. Weber's former post as production manager. He formerly served as manager of engineering.

**Arthur Solgas** has been appointed production manager for Controlled Rubber Products, Inc., Willoughby, O. For the past 18 years, he had been serving with Thompson Products, Inc.; most recently as supervisor of chemical engineering.

**Richard A. Steenrod** has been appointed materials engineer for General Electric Co.'s silicone products department, Waterford, N. Y. His job will be to provide technical information and assistance to design, process, and product engineers.

**Willard deCamp Crater, Jr.,** has been appointed marketing director of W. R. Grace & Co.'s polymer chemicals division. He previously served as manager of Marvibond sales for United States Rubber Co.'s Naugatuck Chemical division.

Earl F. Harris

**Earl F. Harris** has been elected president of Rodney Hunt Machine Co., Orange, Mass. With the firm since 1946, he became vice president in 1947, and executive vice president in 1952. Former president **Carl C. Harris** will continue to serve the company as chairman of the board.

**C. Ronald Howey** has been appointed development department manager for Naugatuck Chemicals, a division of Dominion Rubber Co., Ltd. Formerly the assistant manager, he succeeds **C. W. Gates,** who has returned to the Naugatuck Chemical division of United States Rubber Co.

**Ivan E. Welborn** has been named superintendent of Borden Co.'s new formaldehyde and synthetic resin plant in Fayetteville, N. C. He joined Borden as a control chemist, and has been serving as superintendent of the Kernersville, N. C., plant. **John R. Lowery, Jr.,** succeeds him at that position.

**Herbert A. Fox** has been named director of L. O. F. Glass Fibers Co.'s future planning division, and will make his headquarters at the firm's new research center in Waterville, O. He formerly served as technical manager of the L. O. F. plant in Parkersburg, W. Va.

**Marvin W. Butler** has been appointed Eastern sales manager for Ferro Corp.'s fiber glass division, and will maintain headquarters at Glen Goin Road, Alpine, N. J. His latest position was general sales manager of the J. Weber Mfg. division, Bloomsburg Mills.

David D. Jones

**David D. Jones** has been elected president and general manager of Extruded Plastics, Inc., Norwalk, Conn. He succeeds **Charles E. Slaughter,** who recently retired. Mr. Jones formerly served as vice president of the firm, which is a subsidiary of Vick Chemical Co.

# New Materials

*Write item numbers on Readers' Service card to obtain more information.*

## High-Boiling Lacquer Solvent

Ethyl amyl ketone, a high-boiling solvent for nitrocellulose lacquers and vinyl coatings, is now available in tank-car quantities from Shell Chemical Corp. A colorless, stable liquid, the material's empirical formula is given as 5-methyl-heptanone-3.

Other features claimed for EAK include a low evaporation rate, high blush resistance, and good diluent tolerance. Specifications are listed as follows:

| | |
|---|---|
| Molecular weight | 128 |
| Boiling range, °C. | 157-162 |
| Specific gravity | 0.819-0.823 |
| Vapor pressure @ 70°F., psi. | 0.04 |
| Flash point, Tag open cup, /F. | 138 |
| Viscosity @ 25°C., cps. | 0.8 |
| Weight, lbs./gal. | 6.83 |
| Solubility in water, % | 0.26 |
| Water in EAK, % | 0.9 |
| Surface tension @ 24.5° C., dynes/sq. cm. | 28.4 |
| Refractive index | 1.4149 |

*Readers' Service Isem M-1*

## Barium-Zinc Vinyl Stabilizer

A co-precipitated barium-zinc soap in the form of a white powder has been introduced by Advance Solvents & Chemical, division of Carlisle Chemical Works, Inc., as a vinyl stabilizer in calendering, extrusion, and floor tile processing. Designated Advastab XBZ-155, the material protects vinyl articles from hydrogen sulfide staining.

Effective in heavily pigmented compositions and in the presence of phosphate plasticizers, XBZ-155 also provides lubrication. In common with other zinc stabilizers, the material is best used in combination with an epoxy plasticizer or co-stabilizer. It is insoluble in plasticizers, but can be ground or milled to a uniform paste. Weight per gallon is 3.9 pounds.

*Readers' Service Item M-2*

## Two Azo Red Toners

Sherwin-Williams Co.'s color and chemical division has announced the introduction of two azo red toners, designed specifically for the plastics industry. Brilliant yellow-red in shade, the toners are produced in both resinated and non-resinated forms designated Arcturus Red CP 1275 and 1270, respectively.

Tests indicate suitability in vinyl and polystyrene formulations. Possessed of excellent heat stability, the pigments exhibit neither migration nor crocking. Properties and color are similar to Lake Red C; however, water and bacon fat bleed are considerable less. Other properties are listed as follows:

| | CP 1270 | CP 1275 |
|---|---|---|
| Specific gravity | 1.63 | 1.5 |
| Bulking value, gal./lb. | 0.07364 | 0.08 |
| Weight per solid gal., lbs. | 13.58 | 12.5 |
| Light resistance, full shade | Fair | Fair |
| Tints | Poor | Poor |
| Ease of grinding | Very good | Good |
| Heat stability | Excellent | Excellent |
| Corrosion resistance | Very good | Very good |

*Readers' Service Item M-3*

## Vinyl Plastisol Dispersant

A high-boiling, low-viscosity monomer which acts as a dispersant for plastisol-grade vinyl resins has been introduced by Carbide & Carbon Chemicals Co. Designated MG-1, the material is polymerized during plastisol fusion.

Advantage of MG-1 as a compounding agent depends on the fact that it retains no plasticizing action after polymerization. Volatility is of the same order as DOP, and fluid plastisols may be prepared by using the material either alone or in blends with conventional plasticizers. Plastics of any desired rigidity can be obtained, depending on the concentration of MG-1 in the plasticizer blend. The monomer is expected to be of interest also in calendering, extrusion, and other hot-molding techniques.

Property data are reported as follows:

| | |
|---|---|
| Viscosity at 25°C., cps | 12.2 |
| Specific gravity | 1.078 |
| Color, Gardner | 3 |
| Refractive index at 30° C. | 1.459 |
| Weight at 25°C., lbs/gal. | 8.5 |
| Volatile loss at 375°F. mgs./sq.cm. of surface | 10 |

*Readers' Service Item M-4*

## Two Synthetic Waxes

Two new waxes, which are purely synthetic polymers of carbon monoxide and hydrogen, are presently available through Dura Commodities Corp. Designated FT-200 and FT-300, the waxes are compatible in the melt with mineral waxes, most vegetable waxes, and resins in all proportions. In combination, their high solidification points will predominate.

FT-waxes are soluble hot without residue in all known hydrocarbon solvents, though solubility decreases in relation to the percentage of oxygen in the solvent. Within the plastics field, they serve as hardeners for polyethylene and polyisobutylene, and as lubricants for PVC. As mold and calender lubricants, they are used in powder form.

Following are specifications quoted for the materials:

| | FT-300 | FT-200 |
|---|---|---|
| Melting point, Ubbehohde, °F. | 221-225 | 212-219 |
| Solidification temperature, °F. | 205-212 | 194-202 |
| Penetration, 100 gm., 5 sec., 77° F. | 1 | 3-5 |
| Acid value | 0 | 0 |
| Saponification value | 0 | 0.5 |
| Ash content, % max. | 0.01 | 0.01 |
| Color | White | White |
| Dielectric constant | 3 | 3 |
| Electrical resistance, ohms x cm. | $10^{15}$ | $10^{15}$ |
| Electrical breakdown strength, kv./mm. | 16 | 14 |

*Readers' Service Item M-5*

## Methyl Silicone Emulsion

A 35% base emulsion of methyl silicone in water, intended for use as a mold release, has been introduced by General Electric's Silicone Products department. Designated SM-62, the compound is extremely stable when heated and after dilution. No creaming or separation was found after 30 days at 2% silicone solids in hard water, nor did the material cream after 16 hours at 80° C.

Weight per gallon is approximately 8.2 pounds. The emulsion contains a rust inhibitor, and will have little or no tendency to cause rusting in the shipping and storage container. About 0.025-0.1% of sodium nitrite should be added to the dilution water, however.

SM-62 is best applied by spraying, but wiping and brushing are also used. The material has a variety of uses as a release agent, among which are vinyl tiling, laminating plates, embossing rolls, conveyor belts, and compression, transfer, and injection molds. SM-62 is available in Canada from Canadian General Electric's chemical materials section.

*Readers' Service Item M-6*

## Four Foundry Phenolics

Four Resinox foundry resins have been developed by Monsanto Chemical Co.'s plastics division for the coating of sand used in shell molding. Physical properties and other data will be considered individually.

Resinox RI-4041 is a reddish-brown, semi-viscous liquid phenolic. Specifically developed for hot coating, the resin has a Gardner viscosity of 4,500-6,500 cps. Solids content is 72-76%. Hexamethylene tetramine, 14% by weight, is required for cure; and 3% by weight of lubricant RI-4048. These two materials are mixed with the sand in a Speed Mullor apparatus, using a skip hoist for 15 seconds. Resin is added, followed by nine minutes mixing at 225-300° F. "Quench" water cools the sand, and the mixture is dumped onto vibrating screens. Following rescreening, the material can be stored for periods up to one year.

Resinox RI-5043 is a cold-coating phenolic resin in alcohol solution, and is intended for shell core and shell mold blowing methods. A typical formulation involves the use of 100 pounds of sand, 4.17 pounds resin (2½% solids), 0.35 pounds hexamethylenetetramine, and 0.075 pounds of a lubricant. Properties are reported as follows:

| | |
|---|---|
| Solids content, % | 58-62 |
| Viscosity, cps. | 300-500 |
| Free formaldehyde content, % max. | 0.5 |

Resinox RI-5063 is a powdered phenolic resin developed for cold coating of sand, and is designed for use in shell core and shell mold blowing. A typical formula uses 100 pounds of sand, 2.5 pounds of 2½%-solids resin, 8.5 ounces of alcohol, and 2.9 ounces of water. Properties are as follows:

| | |
|---|---|
| Color | White-light amber |
| Softening point, °C. | 90-100 |
| Film cure rate, 150° C., sec. | 40-60 |
| Flow, mm. | 20-40 |
| Particle size, retention on 200 mesh screen, % | 1.5 |
| Nitrogen content, % | 4.65-5.15 |

Resinox RI-5064 is a powdered phenolic resin developed for cold coating sand used in making shell molds and shell cores with dump box or blowing techniques. Reportedly excellent for alcohol deposition, the resin requires no lubricant or catalyst. A typical formula uses 100 pounds of sand, 4.5 pounds of resin (4½% solids), 15 ounces of alcohol, and five ounces of water. Softening point is 95-105° C., and flow is determined at 12-24 mm. Other properties are identical to RI-5063.

*Readers' Service Item M-7*

## Thixotropic Agent for Paints

A thixotropic agent for all types of latex paints, Cellosize WP-4400, has been introduced by Carbide & Carbon Chemicals Co. A hydroxyethyl cellulose compound, the material is marketed in the form of a water-soluble, free-flowing, white powder. Cellosize, being non-ionic, is stable in the presence of salts and acids.

The powder is sifted into water with continuous agitation, using a high-speed propeller-type mixer. Good mechanical and viscosity stabilities are obtained, and Cellosize does not gel at elevated temperatures. This latter feature makes it particularly useful in hot processing and baking operations.

Cellosize is available in two-, four-, and 13-pound Fiberpak containers, and in 30- and 85-pound Leverpak drums. Physical properties are reported as follows:

| | |
|---|---|
| Viscosity, 2% aqueous soln., cps. | 3,500-5,000 |
| Salt content, max., % by weight | 4 |
| Solubility in water, % by weight | 99 |
| Moisture content, % by weight | 5 |
| pH, 2% soln. | 6-8 |

*Readers' Service Item M-8*


VANSTAY Z

zinc bearing chelator for PVC resins imparts outstanding clarity, stability and resistance to sulfur staining when used as recommended with other VANSTAYS in many vinyl products.

*Plastisols, Organosols, Extruded Goods*

Use 1.5 VANSTAY R with .5 VANSTAY Z for maximum resistance to process heat and good service life.

*Film, Sheeting, Molded Products*

Use 1–1.5 VANSTAY HT with .5–1.5 VANSTAY Z to obtain the required protection.

*When Roll plating is a problem:*

**Use 1.5 VANSTAY N with 1.5 VANSTAY Z as the stabilizing system.**

*Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.*

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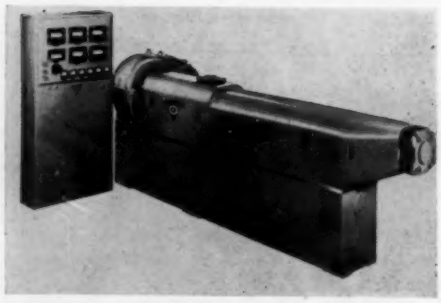
R. T. Vanderbilt Co., INC.
230 PARK AVENUE, NEW YORK 17, N. Y.

# New Equipment

*Write item numbers on Readers' Service card to obtain more information.*

## High-Efficiency Extruders



Prodex's No. 57 extruder with 4½-inch screw.

Prodex Corp. has introduced a new series of extruders, designated No. 57, which feature a Le/D ratio of 20:1 (Le being the length of the barrel from the front end of the feed opening to the front end of the barrel; and D the inside diameter). More precise temperatures are maintained, it is claimed, due to the three-position electronic controllers which automatically actuate the stainless steel heaters and turbo air coolers.

The cylinder is bolted to one end of the Meehanite feed section; the thrust housing to the other end. This housing contains a large, roller thrust bearing between two widely-spaced radial roller bearings for maximum life. A flexible coupling isolates the housing from the herringbone gear transmission, thus preventing misalignment which could occur through differential thermal expansion and shock loads. The expansion support near the front end of the cylinder maintains the screw and cylinder center perfectly level at all times.

The herringbone gear transmissions are said to transmit full horsepower down to half the full motor speed, and reportedly can take twice the rated motor speed at 1,750 rpm. input. The control cabinet, built according to JIC specifications, features harness wiring and terminal-strip construction. No. 57 is available with five different screw diameters: 2½, 3½, 4½, six, and eight inches. Other specifications are reported as follows:

| | 2½-inch | 3½-inch | 4½-inch | 6-inch | 8-inch |
|---|---|---|---|---|---|
| Capacity, lb./hr., plast. PVC. | 120 | 225 | 525 | 700 | 1,200 |
| Polyethylene | 80 | 150 | 350 | 460 | 800 |
| Screw length, in. | 54 | 75 | 97 | 129 | 173 |
| Thrust bearing capacity, dynamometer load, lbs. | 143,000 | 196,000 | 270,000 | 465,000 | 600,000 |
| Floor space required, less motor, in. | 26 x 99 | 33 x 126 | 41 x 155 | 50 x 215 | 56 x 260 |
| Weight without motor, bs. | 2,500 | 3,500 | 6,000 | 9,000 | 12,000 |

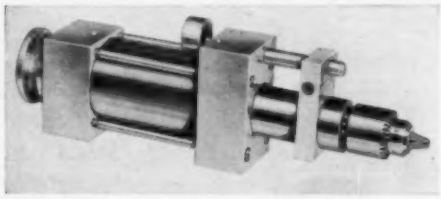
*Readers' Service Item E-1*

## Pneumatic Drill Unit

A pneumatic machine tool, designed for tapping, countersinking, reaming, drilling, and other machine operations which require rotary and feed motions, has been introduced by Alkon Products Corp. Designated the Model 150 Drill Unit, the tool is available with 1½-, three-, and six-inch strokes.

Rated capacity is ½-inch in steel, and maximum speed is 9,000 rpm. Over-all dimensions are as follows: width, 2⅛ inches; length, 8$^{11}/_{32}$ inches; and height, 3¼ inches. Model 150 employs the company's trilobe polygon drive, with ground and plated wear surfaces.

For light thrust applications, the drill can be operated with a three-way valve connected to the downstroke port. This is done by connecting the same line pressure to both ports. Where full line pressure thrust is required, a four-way valve is recommended.



Alkon's Model 150 pneumatic drill.

*Readers' Service Item E-2*

Glengarry Injecto-Weigh unit with compensator (top), plug-in control box (center), and pick-up head (bottom).

## Compensating Weigh Feeder

A new weigh feeder with automatic compensator and remote control box has been introduced by Glengarry Equipment Corp. Referred to as the Injecto-Weigh series 700, the unit reduces the amount of weight in a shot if a cushion of only 0.001 inch develops. In addition, a pilot light notifies the operator that something is amiss.

The compensator consists of a self-contained precision pick-up and controls, and so arranged that it functions only when there is too much material ahead of the ram. The automatic pick-up head is installed without the need for micro-switches; two holes are drilled and tapped into the injection machine itself.

The remote control box, a plug-in unit, can be replaced in a manner of seconds. A graduated beam provides for visual weight indication. All contact parts are fabricated of stainless steel, and various types of buckets are available. The base measures 17 by 18 inches, and the over-all height is approximately 26 inches.

*Readers' Service Item E-3*

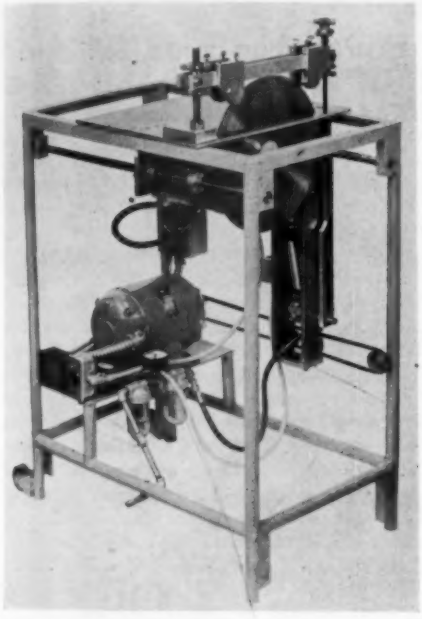
## Fully-Automatic Cut-Off Saw

A traveling cut-off saw for rigid extrusions has been placed on the market by

Rainville Co. of Calif., Inc., national distributors for Vern Emery Co. Designated the Emery Automatic Cut-Off Saw, SP series, the unit travels with the extrusion while cutting.

The saw is actuated by impulse from either limit switch or the lineal measuring unit. Smooth, flat cuts up to four inches in diameter are made at the rate of 30 per minute. Features include life-time lubricated precision bearings, Bellows Filter-Oiler, dolly wheels, and leveling screws. A simple hold-down mechanism minimizes set-up time.

Width of the over-all unit is 20 inches; length, with run, is 30 inches. Table height is adjustable to 42 inches, and maximum saw diameter is 14 inches. A mandrel speed of 1,920 rpm., can be obtained.



Emery Cut-Off Saw, SP Series.

*Readers' Service Item E-4*

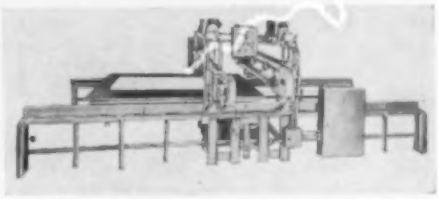
## Leveling & Splitting Machine

A table-type leveling and splitting machine with twin cutting heads has been placed on the market by Falls Engineering & Machine Co. Designed for use on polyurethane and PVC slab stock, its potential production is exactly double that of Falls' original single-head model.

The new machine levels and splits stock to 1/8 inch (1/16-inch with certain materials), and handles foams up to 84 inches wide by 13½ feet long. Stock slabs are placed on the power-driven table, which then moves toward one of the splitting heads. As sheets are sliced-off, the head automatically adjusts itself to clear the stock. The table moves on, reversing itself and returning to the original position. The second cutting head indexes itself into splitting position, and a second cut is made of pre-determined thickness.

An abrasive covering on the table creates friction which, in turn, holds the stock in place during cutting. The table is made of marine plywood, and is fastened to a steel frame mounted on wheels. Four table sizes are available: 64 by 110 inches, 64 by 162 inches, 84 by 110 inches, and 84 by 162 inches.

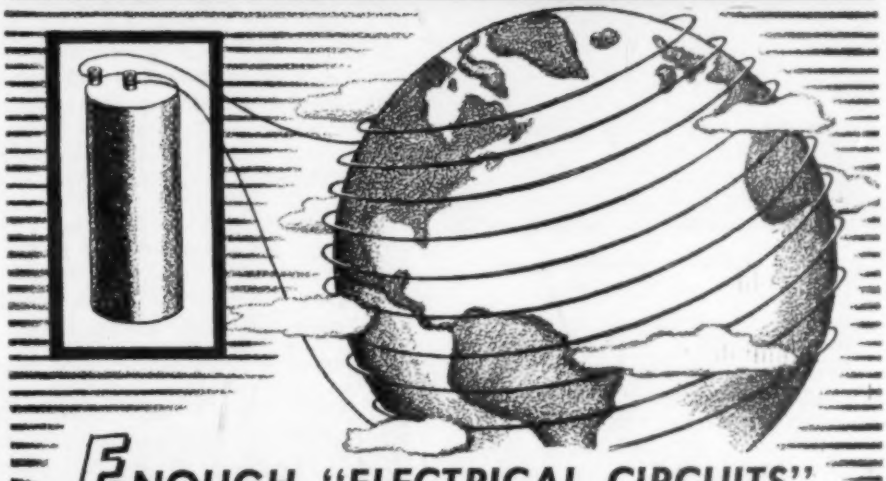
The heads are vertically adjustable ¼-12 inches above the table top. An automatic, self-indexing mechanism sets the depth of cut to the required thickness. The heads face each other, each 12 inches from the center of the machine, and are completely guarded except at the cutting edges. Double compression rolls within each head hold the stock firmly, gage the stock, and produce an accurate thickness of split.



Falls' twin-head, leveling & splitting unit.

*Readers' Service Item E-5*


"Colloid Corner" by COLUMBIAN



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# New Products

*Write item numbers on Readers' Service Card to obtain more information.*

Patrice Decores in self-adherent vinyl.

## Self-Adhesive Plastic Motifs

Die-Cut motifs of Firestone Plastics' Velon vinyl film in 12 different design groupings are available from Patrice, Inc. Called Decores, the plastic motifs have an adhesive backing which is adherent to any clean, smooth surface. The adhesive is protected by a paper backing, which is removed just prior to application.

Designs include a selection of floral patterns, fruits, vegetables, animated pets, and circus patterns. Die-cut, they offer clean outlines around each motif. No marks are left after removal.

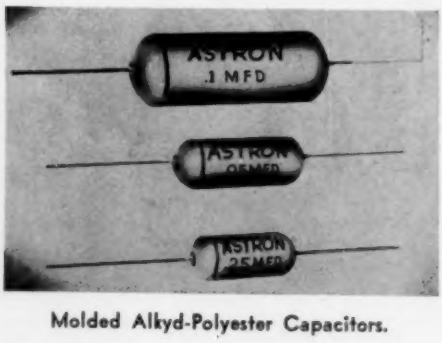
*Readers' Service Item P-1*

## Alkyd-Polyester Capacitors

Blue Point and Comet Metallized paper tubular capacitors produced by Astron Corp. now offer complete protection against moisture and humidity, according to latest reports. The new process of manufacture involves molding an alkyd shell around the capacitor body, sealing it with the exception of two small holes for accommodating the wire leads, and filling these holes with polyester material.

The alkyd material used in this application is Plaskon, a product of Allied Chemical & Dye Corp.'s Barrett Division. It reportedly exhibits high capacitance stability, low power factor, and high insulation resistance over a temperature range of —40 to +85° C. Other features include small size, resistance to vibration and shock, ease of identification and installation, and availability in a wide range of colors.

*Readers' Service Item P-2*




Molded Alkyd-Polyester Capacitors.

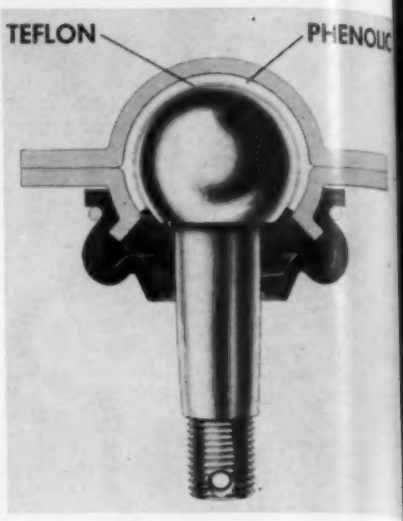
## Modified Styrene Valve Units

Plastic valve units based on Goodyear's Plio-Tuf P100 modified styrene are being used by Milton Roy Co. on controlled-volume pumps for low pressure, moderate temperature applications. The new units are reported to be particularly suitable for handling materials which are corrosive to metals and alloys.

Molded styrene valve units.

The styrene material is molded into "liquid end" valves, with recommended capacity and pressure set at 70 gallons per hour and 150 psi. The pumps are of the reciprocating, positive-displacement type, and have plunger diameters up to 1⅛ inches. Volumetric efficiency can be maintained within a 1% accuracy.

*Readers' Service Item P-3*




Teflon-faced suspension joint in cross-section.

## Fluorocarbon-Faced Ball Joints

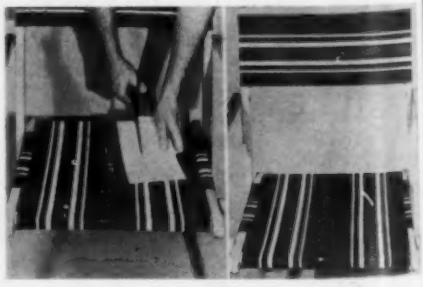
An automobile suspension joint requiring no lubrication has been developed by American Metal Products Co. Teflon tetrafluoroethylene fibers are double-woven with a backing of nylon or cotton to produce a fabric which, when laminated to the surface of a cotton-reinforced phenolic resin during cure, forms a self-lubricating facing for the socket. In addition to reducing friction by more than 50%, the Teflon-faced joint can be used under heavy loads without "squeeze-out."

Used alone, high-impact phenolic cups assured a perfect fit; however, the joint required constant lubrication to prevent stiff steering. The new, preformed bearing is molded in place, assuring a perfect spherical contact between the ball stud and the bearing. Metal parts are coated with a special grease to prevent corrosion, and the joint is sealed. Tests have shown the joint to operate through 10-million cycles without requiring lubrication.

Teflon fabric softens at 550° F., which is well above the temperatures induced by braking and normal car operation. E. I. du Pont de Nemours & Co., Inc., produces the fibers, and Stern & Stern weaves the cloth used in this application.

*Readers' Service Item P-4*

## Vinyl-Impregnated Patches



Patch is cut to overlap rip about one inch (left); torn edges are held firmly in place (right).

A solvent-activated patching material for canvas, leather, and other materials has been developed by Alvin Products, Inc. Called Lab-Patches, the material consists of five by eight-inch swatches of fabric saturated with Bakelite vinyl resins.

Alvin manufactures a home repair kit consisting of two swatches and a half pint of Lab-Solvent, a specially developed formula which activates the inherent adhesive properties of the resin. Patches are cut to cover and overlap the hole or rip, dipped into the solvent for 3-5 seconds, and applied to the undersurface. The patch dries in approximately one hour, and conforms to any shape or contour.

*Readers' Service Item P-5*

Resistoflex's aircraft hose assemblies.

## Fluorocarbon Hose Assemblies

Light-weight, aircraft hose assemblies of Du Pont's Teflon fluorocarbon resin are presently available from Resistoflex Corp. Designated Fluoroflex-T R3800, the lines are permanently preformed to clear obstructions and make connection in the shortest possible length. Preforming permits smaller bend radii with minimum restriction of inside diameter.

Fluoroflex-T hose has a —100 to +500° F. ambient temperature range, and a working pressure of 1,000 psi. Completely inert to all known oils, fuels, and propellants, it has been in flight service for over three years. The Armed Services and CAA have issued their approval.

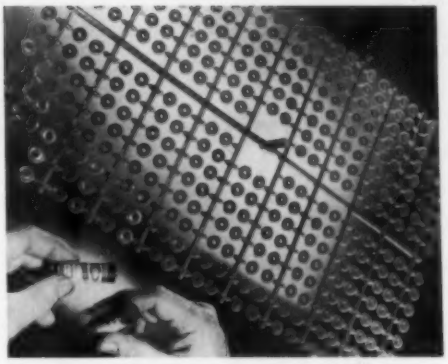
*Readers' Service Item P-6*

## Polyethylene Washers

Polyethylene washers now serve as closing members for Ray-O-Vac's dry cell batteries, offering the added advantage of corrosion-proof insulation. Molded of Eastman Chemical's Tenite, the washers are produced at the rate of 30,000 per hour, 300 in one shot.

In assembly, the washer is forced over a cell's brass-capped central carbon stick to effect a tight seal. The perimeter is sealed by crimping the zinc cap over the outer edge of the washer.

*Readers' Service Item P-7*



Multiple-shot molding with Tenite.

## Molded Rubber Vacuum Bags

Molded rubber blankets or bags of virtually any shape are presently available from H. K. Porter Co.'s Quaker Rubber division, for use in the vacuum molding of any reinforced plastic laminates. Featuring a temperature resistance of 240-250° F., and a uniform rate of stretch during cure, the bags reportedly will not damage the mold, nor will they leave seams which would show up in the finished product.

The bags can be preformed on the mold by applying vacuum and curing at low temperatures. This method produces a bag which is not only inexpensive to make, but also one which holds its shape over a longer period of time. Tears can be repaired for as little as the cost of a cold patch. Specific molds should be shipped to Quaker in order to assure perfect alignment of the curing bag, except where size and weight prohibit.

Quaker's vacuum holding bag.

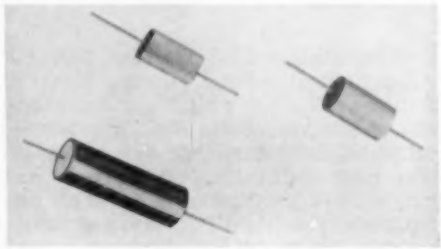
*Readers' Service Item P-8*

## Dielectric Capacitor Lines

Two new lines of Mylar dielectric capacitors, one uncased and the other in a mineral-filled phenolic case, have been introduced by Condenser Products Co., division of New Haven Clock & Watch Co. The uncased line is available in both flat and round shapes, and is designed primarily for the radio and television industry. Phenolic-encased capacitors can be used in similar applications, and with printed circuits.

Uncased units are processed capacitors, with either inserted tab or extended foil wrapped in a layer of Mylar tape and sealed with a thermosetting adhesive. End seals are of epoxy resin. The phenolic case offers high insulation resistance, even under very humid conditions. Units are of the extended foil type with color-coded epoxy end seals.

Both lines have a temperature range of —55 to +85° C., and an insulation resistance of 100,000 megohms per microfarad. Other specifications include a capacitance change of 2% at one kc. and at temperatures of 25-85° C., and a power factor of 0.5% at 1,000 cycles per second.



Condenser Products' phenolic-cased and uncased capacitors.

*Readers' Service Item P-9*

## Molded Plastic Closures

Molded plastic closures designed specifically for toiletry and cosmetic packages have been introduced by Owens-Illinois Glass Co.'s closure & plastics division. Called the Reverse Taper Empress, the cap is produced in a wide range of urea colors, and in the darker phenolic shades.

Four sizes are available: 15, 18, 20, and 22 millimeters. Side ribs enhance appearance but since they do not extend over the top, they leave adequate room for price marking.

Reverse Taper Empress urea closures.

*Readers' Service Item P-10*

# New Literature

*Write item numbers on Readers' Service card to obtain more information.*

**"Dodecene Oxide."** Bulletin No. 73. Becco Chemical Division, Food Machinery & Chemical Corp. 5 pages. Typical properties of this epoxidized olefin are given, together with its chemical reactions and use as a solvent, stabilizer, plasticizer, lubricant, surfactant, corrosion inhibitor, and alkyd raw material.

*Readers' Service Item L-1*

**"Unplasticized PVC Pipe and Fittings."** Alloy Tube Division, Carpenter Steel Co. 6 pages. Physical properties, dimensions and weights, maximum working pressures, calculated burst pressures, thermal expansion and contraction, fitting types and weights, and installation of the firm's two types of unplasticized PVC pipe and fittings are described in this bulletin.

*Readers' Service Item L-2*

**"Plasticizer 84."** Eastman Chemical Products, Inc. 4 pages. This distilled butyl octyl phthalate plasticizer is designed as a replacement for dibutyl phthalate in nitrocellulose lacquers. Properties, compatibilities, cold check resistance, and permanence characteristics are listed.

*Readers' Service Item L-3*

**"Six Small Air-Cooled Compound Pumps."** Bulletin No. 403. Kinney Mfg. Division, New York Air Brake Co. 4 pages. This bulletin contains photographs and lists specifications for all six models. They range in size from a ¼-hp unit with a two-cubic foot displacement per minute to a 3-hp unit which displaces 46 cubic feet per minute.

*Readers' Service Item L-4*

**"A List of Dag Dispersions for Industry."** Acheson Colloids Co. 4 pages. This fifth revision lists 41 colloidal and semi-colloidal dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, and acetylene black. Carriers and diluents are also listed, along with typical applications and physical data.

*Readers' Service Item L-5*

**"Atlas Corrosion-Proof Cements."** Bulletin 5-2. Atlas Mineral Products Co. 12 pages. Technical data on five standard cements: furan, phenolic, sulfur, polyester, and silica-based materials are given in this bulletin. The first type has good resistance to a wide range of chemicals, and the others are designed for specific resistance to fluorides, non-oxidizing acids, bleaching solutions, and highly-concentrated acids, respectively. Numerous illustrations are included, together with graphic data on resistance characteristics and a description of the function of brick and cement in corrosion-proof construction.

*Readers' Service Item L-6*

**"Het Anhydride."** Bulletin No. 43. Hooker Electrochemical Co. 17 pages. This revised bulletin describes general properties, typical reactions, and applications for the material, which is used as a hardener and curing agent for liquid epoxy resins. New data on high-temperature flexural properties and heat aging of epoxy laminates are included.

*Readers' Service Item L-7*

**"Questions and Answers about the Market for Plastic Housewares."** Survey No. 2. Monsanto Chemical Co., Plastics Division. 16 pages. Statistics and graphic data on growth of the market, amount of plastics used, best-selling housewares, prices, methods of distribution, geographic distribution, and a summary are included in this bulletin.

*Readers' Service Item L-8*

**"Dillon Mechanical Force Gauge—Model X for Precision Measurement of Pressure, Tensile, or Torque."** Bulletin 11E. W. C. Dillon & Co., Inc. 6 pages. This flyer contains 23 illustrations, plus description, of applications for the gage. Four special models are depicted, and tables are included giving pertinent dimensions.

*Readers' Service Item L-9*

**"Conolon Fiberglass Ducting."** March Narmco News. Narmco Mfg. Co. 8 pages. Aircraft ducting of unusual size, shape, and diameter-variation is described and illustrated, together with design considerations.

*Readers' Service Item L-10*

**"Fundamentals of Injection Molding Cellulosics."** Bulletin A-16, dated March 1, 1956. Celanese Corp. of America, Plastics Division. 7 pages. Designed to provide up-to-date information on molding with new large capacity equipment, this bulletin gives data on the physical properties of cellulose acetate for injection molding; molding techniques; machine variables; typical machine operating conditions; mold and design gating; and elimination of part defects.

*Readers' Service Item L-11*

**"Thermaflow Data Sheets."** Thermaflow Chemical Corp. Dated Jan. 1, 1956. These are individual data sheets on Thermaflow 100, 200, 300, 400, 500, 1000, 2300, and 2400. The materials are reinforced polyester molding compounds. Data given on each material include compound properties, and physical, mechanical, and chemical molded properties.

*Readers' Service Item L-12*

**"New Developments in Sanitary Blenders by American for Mixing Powders, Pastes, and Liquids."** American Welded Tank & Machinery Corp. 8 pages. Three new features in spiral and heavy-duty blenders are described in this catalog covering sizes, machine construction, and machine design. The blenders are suitable for the chemical and food processing industries.

*Readers' Service Item L-13*

**"Penacolite Brittle Resins B-1A, B-16, B-22."** Technical Bulletin C-6-230. Koppers Co., Inc. 6 pages. The first two adhesive preparations are solid condensation products of resorcinol and formaldehyde; the third, a phenol-modified resorcinol-formaldehyde resin. Property data, including solubility, pot life, viscosity, and stroke cure time, are included.

*Readers' Service Item L-14*

**"Sorvall Specialized Laboratory Instruments."** Ivan Sorvall, Inc. 8 pages. This catalog describes and illustrates the complete line of Sorvall laboratory instruments, including centrifuges, microtomes, homogenizers, automatic pipettes, conductivity bridges, gas and moisture testers, and electrophoresis and chromatography equipment.

*Readers' Service Item L-15*

**"Big Ticket Polyethylene Houseware Designs."** Monsanto Chemical Co., Plastics Division. 23 pages. A collection of new design concepts for large-size polyethylene housewares, including photographs and schematic diagrams.

*Readers' Service Item L-16*

**"Impulse Sales Power in Your Product."** Amsco Packaging Machinery, Inc. 4 pages. This bulletin contains 24 photographs illustrating the use of transparent plastic packaging, which can be accomplished in one operation with the Amsco Hi-Speed Sealer.

*Readers' Service Item L-17*

# Book Reviews

**"Fluorine-Containing Polyethers."** O. R. Pierce, D. D. Smith, and R. M. Murch, Dow Corning Corp., for Wright Air Development Center. Order PB 111986 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 57 pages. Price, $1.50.

Fluorine-containing polymers of the polyether type were synthesized and evaluated as sealants, rubbers, coatings, and adhesives. The desired properties were high thermal stability, fuel and oil resistance, retention of properties to —65° F., and resistance to fuming nitric acid and ozone. The monomers were prepared by dehydrohalogenation of the corresponding halohydrins.

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**"Poly FBA—A Fluorinated Acrylic Elastomer for High Temperature Service in the Presence of Aircraft Fuels and Lubricants."** H. C. Hamlin, Wright Air Development Center. Order PB 111946 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 60 pages. Price, $1.50.

This research report contains an analysis of properties and applications for Poly FBA, a new synthetic elastomer. The material is said to be stable at high temperatures, and to be resistant to fuels, oils, and solvents. Results suggest its use in a variety of mechanical goods such as seals, diaphragms, hose, and coated fabrics.

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**"Statistical Summary No. 1."** Manufacturing Chemists' Association, Inc., 1625 Eye St., N. W., Washington 6, D. C. Paper, 8½ by 10¾ inches, 50 pages. Price 60¢.

This supplement to the Chemical Statistics Handbook, fourth edition, is concerned primarily with the wage, hour, employment, production, and price trends in the chemical industry as compared with all manufacturing. Editorial content consists entirely of tabular and graphic data taken from such government sources as the Department of Labor, Federal Reserve Board, Bureau of Census, and the Tariff Commission. Supplement No. 2 will be issued shortly after the completion of the 1954 census of manufacturers.

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**"Resins, Rubbers, Plastics Yearbook 1955."** Edited by H. Mark, E. S. Proskauer, and V. J. Frilette. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. Cloth, 6¾ by 9¾ inches, 1148 pages. Price, $35.00.

This volume, issued with the cooperation of the Institute of Polymer Research, Polytechnic Institute of Brooklyn, N. Y., consists of abstracts of papers on resins, rubbers, and plastics, which had been published in various journals throughout the United States and abroad. The abstracts differ from conventional types in that they contain original data, graphs, charts, photographs, and tables.

Being more complete, they should eliminate many of the cases where research workers are forced to refer to the original works. An author and a subject index are included.

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**"British Plastics Year Book 1956."** 26th Edition. Iliffe & Sons, Ltd., Dorset House, Stamford St., London S. E. 1, England. Cloth, 9¼ by 6½ inches, 740 pages. Price, $5.90.

This classified guide to plastics manufacturers and products in the United Kingdom contains nine tabbed sections, each revised from earlier editions. The general section includes a review of recent patents, new companies formed in 1955, and a listing of British Standard Specifications.

Materials and material suppliers are listed in a separate section, and a special products section gives an account of available molded and fabricated plastic goods, together with their manufacturers. A plant and equipment section gives a rundown on engineering and chemical equipment presently on the market. The glossary alphabetizes proprietary names and technical terms.

Names and addresses of British and overseas firms are listed in a separate section, together with technical organizations, consultants, and periodicals. A Who's Who section, an association and federations section, and a technical data section conclude the work.

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**"Professional Engineer's Examination Questions and Answers."** William S. La Londe. McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y. Cloth, 462 pages. Price, $6.50.

This guide to examinations for the professional engineer license, the land surveyor license, and the engineer-in-training certificate is designed for the new graduate and the older practicing engineer. Over 500 questions and problems have been taken from sample sheets or past examinations.

Part I contains general information on certification, and the addresses of all registration boards. Part II contains questions on chemistry, engineering materials, kinetics and statics, thermodynamics, civil engineering, electrical engineering, mechanical engineering, structural engineering, and land surveying. Solutions are given in Part III, and Part IV contains engineering symbols.


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# Abstracts of Important Articles

## Materials

**"A Simple Method of Identification of Commercial Polyamides,"** F. Stuhlen and H. Horn, *Kunststoffe*, 46, 2, 63 (Feb. 1956).

A qualitative method is described which uses different solubility and crystallization behaviors of the hydrolysates obtained from HCl hydrolysis, in conjunction with melting point determinations of the polyamides and the acids precipitated during hydrolysis.

**"Effect of Top-Coats on Plasticizer Migration in PVC Leathercloth,"** H. E. Frey, *Kunststoffe*, 46, 2, 81 (Feb. 1956).

The effect of plasticizer migration on PVC leathercloth top-coats is discussed, and a modification of the rub-off test is described.

**"The Testing of Plastics Moldings,"** C. M. F. v. Meysenbug, *Kunststoffe*, 46, 3, 95 (March 1956).

Use testing depends on the shape and application of the molding, so it is not possible to establish uniform methods and generally valid standards. On the other hand, materials testing uses standardized specimens and test methods, so results are standardized but not comparable to use test results.

**"Practical and Theoretical Considerations on the Plasticization of PVC,"** A. Mathe, *Inf. Plastiques*, 12, April 15, 1956.

The author first reviews the practical work carried out to evaluate a plasticizer and the properties it confers on a PVC. Next, he considers research on the inner mechanism of the action of the resin-/plasticizer system. He concludes that little is still known in the theoretical field on the action of plasticizers, and empiricism predominates. Through more profound research, however, new paths are being opened up. (In French).

**"The Study of Macromolecules by means of Infra-Red Spectrography,"** C. A. Ceselli, *Materie Plastiche*, 22, 1, 3, (Jan. 1956).

A brief review of results of qualitative investigations carried out by various research workers in recent years by means of infra-red spectrography on polyethylene, polystyrene, PVA, natural and synthetic rubbers, polyamides, and cellulose derivatives. (In Italian).

**"Foam Plastics,"** Walter Brenner, *Materials & Methods*, 43, 6, 143 (June 1956).

No. 127 in the magazine's series of articles on engineering materials, this discussion gives information on the chemical composition, physical and mechanical properties, forming and fabrication, and applications of 10 commercially available plastic foams. The foams covered include urethanes, vinyls, polyethylenes, polystyrenes, phenolics, silicones, syntactic, cellulose acetate, epoxies, and ureas.

**"PTFE and PTFCE,"** J. Gadsby, *Rubber & Plastics Age*, 37, 3, 177 (Mar. 1956).

A review of the properties, structural make-up, fabrication, processing, and applications of polytetrafluoroethylene and polytrifluoromonochloroethylene.

**"Recent Developments in Polyester Resins,"** H. Williams, *Trans. Plastics Inst.*, 24, 55, 37 (Jan. 1956).

The chemistry of polyester resins and recent developments in the formulation of polyester resins for particular purposes are surveyed. Among the points taken up are the role of resins for particular purposes are surveyed. Among the points taken up are the role of modifying acids; glycols and the relation between glycol configuration and styrene compatibility; the derivation of the adduct known as HET and the properties it confers; and the use of triallylcyanurate as a cross-linking agent to give heat stability.

**"The Influence of the Degree of Polymerization of High Polymers on Adhesive Power,"** T. Eich, *Kunststoff-Rundschau*, 3, 1, 5 (Jan. 1956).

It is attempted to explain why low-molecular weight adhesives based on cellulose and vinyl esters give better adhesion on porous or non-porous but polar materials, than adhesives of high molecular weight. The factors here seem to be that Van der Waals forces are greater in small molecules, and the sum of the electrical forces at the ends of small molecules is larger than is the case for big molecules. The distribution of molecular weight in a polymer is particularly significant. (In German).

**"What Does the Stress-Strain Diagram of Polyamides Tell the Engineers?"** W. Weidmann. *Kunststoffe*, 46, 1, 16 (Jan. 1956).

Experience with polyamides in the construction of machinery is limited. Until more is known, stress-strain tests can yield useful data on the properties of the material, if diagrams are made and evaluated. This discussion refers specifically to Durethan B K (a Bayer polyamide); the tests also serve when the polyamide is to be compared with other materials. (In German.)

**"Volatility of Vinyl Plasticizers,"** W. J. Frissell, *Ind. Eng. Chem.*, 48, 6, 1096 (June 1956).

A description of suitable processing and service tests to determine the relationship between plasticizer vapor pressure and volatile losses. The tests are discussed and evaluated, and test results are given.

**"Esters of Monofunctional Alcohols as PVC Plasticizers,"** F. Wurstlin and H. Klein, *Kunststoffe*, 46, 1, 3 (Jan. 1956).

Mono and dicarboxylic acids were examined and compared as to plasticizing efficiency, solvent action on PVC, and compatibility with PVC. Under certain conditions, these properties could be improved by the introduction of polar groups (as was shown in the case of azelaic acid). The adverse effect of branching on plasticizing efficiency was observed, and the limitations of Leilich's rule (viscosity as a function of temperature can be used to estimate plasticizing efficiency) are discussed, with special reference to liquid substances. (In German.)

**"Glass as a Reinforcing Material for Plastics,"** E. A. H. Algra, *Plastica*, 8, 11, 575 and 8, 12, 637 (Nov. & Dec. 1955).

A review of the types of glass used and the production and properties of glass fibers and yarns, with special attention to English and metric codes used to designate different types and sizes of yarns. Sizing and pre-treatment of the fibers, and the application of chromium or silane finishes also are described. (In Dutch.)

**"Bascodur—A Highly Corrosion-Resistant Material,"** W. Kunze and K. Vogel, *Plastverarbeiter*, 6, 12, 458 (Dec. 1955).

Bascodur resins are condensation products whose chief components are graphite, coal or other carbon-containing material, and a modified hardenable phenol formaldehyde resin. Its resistance to a number of acids, alkalies, and solutions is listed, as well as its physical properties. Various applications in the construction of chemical apparatus are indicated. (In German.)

**"P. V. C. Extrusion Compounds,"** H. D. Brett, *Plastics (London)*, 21, 222, 15 (Jan. 1956).

The importance of close cooperation between compounders and extruders is emphasized. It is shown how PVC extrusion compounds can be formulated and processed to meet specific requirements.

**"Thermal Properties of Laminates,"** F. R. O'Brien, Sabert Oglesby, Jr., and P. C. Covington, *Modern Plastics*, 33, 12, 158 (Aug. 1956).

Results are given of thermal tests conducted on 15 laminates made with glass reinforcements. Properties tested include specific heat, thermal expansion, and thermal conductivity.

**"Asbestos Reinforcements,"** D. V. Rosato, *Modern Plastics*, 33, 11, 140 (July 1956).

Survey of the various available forms of asbestos reinforcements for molded and laminated plastic products.

**"Mechanical Action of Flexible Foams,"** R. H. Carey and E. A. Rogers, *Modern Plastics*, 33, 12, 139 (Aug. 1956).

The general behavior of urethane and vinyl foams when tested by standard rubber testing procedures is discussed, and several new tests appropriate to plastic foams are described.

**"Superfine Thermoplastic Fibers,"** V. A. Wente, *Ind. Eng. Chem.*, 48, 8, 1342 (Aug. 1956).

The hot melt method of producing fine thermoplastic fibers may be applied readily to those polymers having reasonbly low melt viscosities. Fiber diameters of less than one micron and as low as 0.1 micron are obtainable from the linear polyamides and polyesters. Polystyrene, polymethyl methacrylate, and polytrifluorochloroethylene also yield sub-micron diameters.

## Equipment

**"A Radically New Press and Mold for Mass Production of Large Plastics Shapes,"** C. H. Van Hartesveldt, *SPE J.*, 12, 7, 24 (July 1956).

A press has been developed for producing void-free glass fiber-reinforced plastic moldings.

**"An Apparatus for Measuring the Response of Polymeric Materials to an Oscillating Strain,"** Bryce Maxwell, *ASTM Bull.*, No. 215, 76 (July 1956).

An apparatus is described for determining the real and imaginary components of the dynamic modulus and the mechanical loss factor over a wide frequency range under controlled conditions of temperature and strain magnitude. Data are presented on cellulose acetate butyrate, polyvinyl chloride, and cellulose acetate demonstrating the use of the apparatus.

**"Simplified Drive for Injection Machines,"** Islyn Thomas, *Modern Plastics*, 33, 11, 118 (July 1956).

A new electro-hydraulic drive offers improved economy and higher ram speed, and uses no valves to control pressure and speed. Mold-closing and injection rams are driven by fluid forced from a third cylinder whose piston is geared directly to the driving motor.

## Processing

**"Nylon for Extrusion and Injection Molding,"** J. F. Kohlwey, *Trans. Plastics Inst.*, 24, 55, 53 (Jan. 1956).

This article deals with Akulon, a nylon made in Holland. It discusses the properties in which nylon differs from other plastic materials, and describes the special methods and special designs of extruders and injection molding machines these necessitate.

**"Hot Molding of Manufactures of Glass-Fiber Reinforced Polyester Resins,"** F. Forni, *Materie Plastiche*, 22, 1, 35 (Jan. 1956).

Description of the equipment (preformers, dryers, agitators, presses, etc.), materials, and methods employed in producing articles like containers, valises, aircraft and automobile parts, etc., by hot molding glass-fiber reinforced polyester resins. (In Italian).

## Applications

**"Polyamide-Epoxy Resin Blends for Tooling,"** D. E. Peerman, *Materials & Methods*, 44, 1, 106 (July 1956).

The blends eliminate the need for toxic curing agents, and have higher impact resistance than the conventional epoxy materials.

**"Casting Resins—Their Application to Electronic Engineering,"** H. G. Manfield, *Trans. Plastics Inst.*, 24, 55, 72 (Jan. 1956).

Historical first part precedes a second part dealing with the use of polyester and

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epoxy casting resins in potting electronic sub-units such as transformers. Advantages and disadvantages of the process, factors determining the choice of resins, the types of materials and components that can be potted, and a method of determining whether and to what extent post-curing cycles are necessary are discussed in detail.

**"Blister Packaging,"** N. L. Roberts; "Skin Packaging," J. L. Clemens; "Saran Wrap—Low Moisture and Gas Permeability with Clarity and Strength," L. S. Mounts; and "Tetra-Pak—A New Concept in Liquid Packaging," R. G. Newhall; *Western Plastics*, 3, 7, 17-20 (July 1956).

Brief reviews of recent developments in four fields of plastics packagings.

## General

**"The Role of Plastics in a Balanced National Economy,"** V. E. Yarsley, *Trans. Plastics Inst.*, 24, 55, 3 (Jan. 1956).

Going back to the beginnings of the modern period of chemical investigations, the author shows how the growing use of coal as a source of energy gradually led to the first industrial revolution about 1750. Now, 200 years later, we have the second industrial revolution in which atomic energy is the new source of energy, local availability of natural raw materials has become less significant than formerly (except in war), and chemical synthesis (particularly in the production of synthetic polymers) is playing a special role in the re-orientation of the modern world. The new source of energy could create new high standards of living throughout the world and cause the distinction between the 'haves" and the "have-nots" to lessen. There may be a great new role for cellulose in polymer production, where its use will release much coal, now being burned for conversion into useful materials of construction. At the same time, it would aid in the balancing of the national economy of many lands lacking coal, oil, and natural gas.

**"A Review of Developments in Plastics Engineering, 1954-1955,"** *Mech. Eng.*, 78, 6, 533 (June 1956).

The annual review paper presented before the Rubber and Plastics Division, American Society of Mechanical Engineers.

**"Molecular Structure of Marlex Polymers,"** D. C. Smith, *Ind. Eng. Chem.*, 48, 7, 1161 (July 1956).

Results are presented of investigations showing that the unsaturation pattern points up difference in polymers made by different processes. Branching of olefin polymers was measured by infrared methods, and crystallinity values based on X-ray diffraction and nuclear resonance techniques were assigned to characterize the Marlex materials.

**"Plastics—Engineering Materials,"** C. H. Adams, *Modern Plastics*, 33, 11, 127 (July 1956).

A comparative discussion of plastic materials from the viewpoint of a civil engineer.

**"Marlex Catalyst Systems,"** Alfred Clark, J. P. Hogan, R. L. Banks, and W. C. Lanning, *Ind. Eng. Chem.*, 48, 7, 1152 (July 1956).

Use of supported chromium oxide as a solid catalyst in the production of high polymers of ethylene and other olefins is described. Chromium concentration on silica-alumina bases has been found to have no effect on polymer properties. Results are given of tests on other bases for the catalyst.

**"A Potting Compound and Mold for Precision Pottings,"** W. H. Crandell, *SPE J.*, 13, 7, 20 (July 1956).

The development of a compound and the design of a mold to produce pottings in which properties and control of final dimensions are critical.

**Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. The publishers and their addresses are given below:**

"ASTM Bulletin"
American Society for Testing Materials
1916 Race St., Philadelphia 3, Pa.

"Australian Plastics"
Australian Trade Publications, Ltd.
171 Sussex St., Sydney, Australia

"British Plastics"
Iliffe & Sons, Ltd.
Dorset House, Stanford St.
London S.E.1, England

"Canadian Plastics"
341 Church St., Toronto, Ont., Canada

"Chemical and Engineering News"
1155 Sixteenth St. N.W.
Washington 6, D. C.

"Hule Mexicano y Plasticos"
Filomeno Mata 13-11, Mexico, D.F.

"Industrial and Engineering Chemistry"
1155 Sixteenth St. N.W.
Washington 6, D. C.

"Industries des Plastiques Modernes"
Les Publications Techniques Associees
40 Rue du Colisee, Paris 8e, France

"Kunststoffe"
Carl Hanser Verlag
Leonard Eck Str. 7, Munich 27,
Germany

"Kunststoff-Rundschau"
Brunke Garrels, Verlagsbuchhandlung
Borgfelder Strasse 83, Hamburg 26,
Germany

"Materials and Methods"
Reinhold Publishing Corp.
430 Park Ave., New York 22, N. Y.

"Materie Plastiche"
Via Farneti 8, Milan, Italy

"Matiéres Plastiques"
Galerie du Center, Bloc 3
Rue des Fripiers, Brussels, Belgium

"Mechanical Engineering"
American Society of Mechanical Engineers
29 W. 39th St., New York 18, N. Y.

"Modern Plastics"
575 Madison Ave., New York 22, N. Y.

"Oesterreichische Plastic-Rundschau"
Ployer & Co.
Aegidiengasse 5, Vienna 6, Austria

"Plaste und Kautschuk"
Veb Verlag Technik
12 Unter den Linden
Berlin N.W.7, Germany

"Plastic"
Danish Technical Press
31 Vester Farimogsgade
Copenhagen 5, Denmark

"Plastica"
Kunststoffeninstituut T.N.O.
Julianalaan 134, Delft, The Netherlands

"Plastics"
Temple Press, Ltd.
Bowling Green Lane, London E.C.1,
England

"Plastics World"
Cleworth Publishing Co., Inc.
22 W. Putnam Ave., Greenwich, Conn.

"Plastiques Informations"
94 Rue Saint-Lazare
Paris 9e, France

"Plastverarbeiter"
Verlagsgec. m.b.H.
Herxheim b. Landau/Pfalz, Germany

"Poliplasti"
E.T.A.S., Via Andrea Mantegna 6,
Milan, Italy

"Revista de Plasticos"
Inst. "Alonso Barba"
Serrano 119, Madrid, Spain

"Revue Générale des Matiéres Plastiques"
196 Ave. Jean-Jaures, Paris 19e, France

"Rubber and Plastics Age"
Rubber and Technical Press, Ltd.
Tenterden, Kent, England

"SPE Journal"
Security Bank Bldg., Athens, Ohio

"Transactions of the Plastics Institute"
The Adelphi, Adam St.
London W.C.2, England

# Patent Digest

## Materials

**Acrylonitrile Polymers Stabilized with Certain Alkyl Sulfones.** No. 2,740,766. George W. Stanton and Forrest A. Ehlers, Walnut Creek, Calif. (to Dow Chemical Co., Midland, Mich.).

The composition contains at least 60% by weight of acrylonitrile polymerized in the polymer molecule, a small amount of monoethylenically-unsaturated material copolymerized with acrylonitrile, and 1-20% of an alkyl sulfone stabilizing agent.

**Copolymer of Trifluorochloroethylene and Vinylidene Fluoride.** No. 2,738,343. Albert L. Dittman, Jersey City, Herbert J. Passino, Englewood, and Wilber O. Teeters, River Edge, N. J. (to M. W. Kellogg Co., Jersey City, N. J.).

The thermoplastic copolymer consists essentially of trifluorochloroethylene containing 0.5-6 mol percent of vinylidene fluoride.

**Purification of Fluorocarbons.** No. 2,738,371. Howard Maurice Parmelee, Woodstown, N. J. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Hydrogen content of saturated fluorocarbons is decreased by contacting the materials with an anhydrous ammonia or amine at a temperature of 20-150° C.

**Method of Preparation of Moldable Copolymers of Styrene and Acrylonitrile.** No. 2,739,142. Clifford Jones, Linwood, and Bronson Harris and Frank L. Ingley, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

A homogeneous mixture consisting by weight of 20-35% acrylonitrile, 35-80% styrene, and 0-30% alpha-methylstyrene is heated in a polymerization zone to a temperature of 130-175° C. A polymerization modifier is added in the proportion of 10-40% by weight of the reaction mixture.

**Production of Polyethylene Terephthalate Using an Antimony Compound as Catalyst.** No. 2,739,957. Harry R. Billica, Seaford, Del., and Jonathan Turner Carriel, Pittsburgh, Pa. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Ethylene glycol is reacted under ester interchange conditions with an alkyl ester of terephthalic acid and a saturated, aliphatic monohydric alcohol. Both calcium and antimony catalysts are used in the polymerization.

**Mercaptan Modified Hydrocarbon Polymers.** No. 2,736,723. Frederick W. Breuer and Burt F. Hofferth, Manheim Township, Lancaster County, Pa. (to Armstrong Cork Co., Lancaster, Pa.).

Hard, brittle hydrocarbon resins obtained by the polymerization of petroleum fractions are converted to useful plasticized products by heating the hydrocarbon in the presence of higher alkyl and aromatic mercaptans.

**Polyethylene Modified with Anti-Crack Agent Comprising Copolymer of Vinyl Chloride and an Octyl Acrylate.** No. 2,737,502. William M. Land, Jr., Plainfield, N. J., and Werner T. Meyer, Jackson Heights, N. Y. (to Union Carbide & Carbon Corp., New York, N. Y.).

The composition comprises polyethylene, 2-10% by weight (of the polyethylene) of a copolymer of vinyl chloride and an octyl acrylate, and 0.1-2% by weight (of polyethylene) of an alkaline metal stearate.

**Polymeric Chlorotrifluoroethylene Stabilized with Small Amounts of Chromic Oxide.** No. 2,737,505. Robert W. Finholt, Erie, Pa. (to General Electric Co., Schenectady, N. Y.).

The composition consists of solid polychlorotrifluoroethylene and 0.001-4% by weight of chromic oxide. Improved flex life at elevated temperatures is reported.

**Inhibition of Tetrafluoroethylene Polymerization.** No. 2,737,533. Barnard Mitchel Marks and John Brockway Thompson, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

This composition comprises monomeric tetrafluoroethylene and 0.01-10% by weight of an inhibitor such as alpha-methylvinylbenzene or alpha-methylvinylmethylbenzene.

**Production of Polymeric Products from Styrene and Unsaturated Fatty Compounds.** No. 2,736,716. Arnold John Lowe, Manchester, and Donald Butler, Moston, Manchester, England. (to Oxirane, Ltd., London, England).

The polymers are produced by passing approximately equal weights of styrene and unsaturated fatty compounds through a reaction zone which has been heated to 210-270° C. The reaction is continued until 30-90% by weight of the styrene is reacted.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

**Modified Styrene Compositions.** No. 2,736,715. Henry Brunner, Langley, England. (to Imperial Chemical Industries, Ltd., Great Britain).

A drying, oil-soluble styrene interpolymer is prepared by polymerizing 75-99 parts by weight of styrene and 1-25 parts by weight of a polyhydric alcohol ester in the presence of a Friedel-Crafts catalyst.

**Copolymers of Vinyl Aromatic Compound, Fatty Acid Ester of Epoxy Resin, and a Vegetable Oil.** No. 2,736,717. Charles Frazier, Yonkers N. Y. (to American Cyanamid Co. New York N. Y.).

A styrene and an acid ester of an epoxy material are coreacted at a temperature of 130-215° C. in a mutually-inert solvent which has a boiling point above 110° C. This reaction is carried out in the presence of a tertiary alkyl-substituted peroxide catalyst and a drying or semi-drying oil.

**Phenolic Resin Products and Their Production.** No. 2,736,718. Charles S. Webber, Loudonville, N. Y. (to Norton Co., Worcester, Mass.).

A rapid-curing phenolic adhesive is prepared by heating in an aqueous medium one mol of a monohydric phenol, 1.5-2.8 mols of an aldehyde, and an alkaline condensation catalyst. When a fusible, heat-convertible condensation resin is obtained, the volatile materials are distilled off under vacuum to give an aqueous resin with 60-90% solids by weight.

**Alkyd Resins Modified with Substituted Carbocyclic Acids and Compositions Containing the Same.** No. 2,734,876. Theodore F. Bradley, Orinda, Calif. (to Shell Development Co., San Francisco, Calif.).

The modified resin comprises the reaction product of phthalic acid anhydride, glycerol, and 5-90% by weight of p-tertiary butylbenzoic acid.

**Alkyl Esters and Plastic Compositions Comprising Same.** No. 2,734,884. Paul V. Smith, Jr., and David W. Young, Westfield, N. J. (to Esso Research & Engineering Co., Linden, N. J.).

The composition consists of 100 parts vinyl chloride and 30-60 parts of a neutral ester of phthalic, sebacic, azelaic, or diglycolic acid reacted with carbon monoxide and hydrogen at a temperature of 250-400° F., and a pressure of 150-400 atmospheres.

**Stabilized Chlorine-Containing Resins.** No. 2,734,881. Robert E. Lally, Bedford, and Raymond J. O'Hara, Maple Heights, O. (to Ferro Corp., Cleveland, O.).

The chlorine-containing vinyl resin is stabilized with 0.5-8% by weight of an

admixture of epoxies and aliphatic polyhydric alcohol.

## Equipment

**Automatic Molding Apparatus.** No. 2,743,478. Loraine C. Harlow, Greenfield, and Quincy E. Smith, Indianapolis, Ind. (to Radio Corp. of America, New York, N. Y.).

The phonograph record manufacturing apparatus comprises a pair of molding platens having an open and a closed position; a means, responsive to the opening of said platens, which positions the record label; a cycle control cam shaft; a means, responsive to the opening of the platens, which actuates the cam shaft; a means, actuated by the cam shaft, which positions the other label; and means for supplying the plastic material. Heating and cooling are automatically timed to the molding cycle, and record removal and finishing also are automatic operations.

**Method for Working Synthetic Organic Plastic Materials.** No. 2,746,089. James W. Hendry, Bay City, Mich. (to Tube Turns Plastics, Inc., Louisville, Ky.).

The machine has a restricted passage through which a ram passes for compressing and ejecting the material at working temperatures. A fluent charge is placed in the chamber, followed by the addition of a predetermined amount of cold, dry, pulverulent material. The ram, heated to a temperature less than that of the fluent charge, is brought to bear on the dry surface material and compressed to form a sealing ring.

**Apparatus for Producing Shell Molds.** No. 2,746,104. Emery I. Valyi, New York, N. Y.

The apparatus comprises a pattern, a hopper with discharge opening, a closure means, a supporting frame, a rotating means, and a stop member. The hopper is mounted for rotation about a horizontal axis.

**Molding Apparatus.** No. 2,742,683. Edwin Knipp and Walter Geil, Junkerath, Germany (to Junkerather Gewerkschaft, Junkerath, Germany).

This apparatus for casting molds consists of a pair of gripping arms for turning over the molding boxes, so mounted as to swivel in a horizontal plane; bearings whose axes extend horizontally from the other ends of the arms; gripping claws rotatably-mounted in the bearings for frictional engagement within the vertical walls of the molding boxes; and a means for swiveling the arms to effect positive engagement.

**Extrusion Method and Apparatus.** No. 2,742,669. Thomas J. Rhodes, Clifton, N. J. (to United States Rubber Co., New York, N. Y.).

The apparatus for shaping highly viscous and heat-sensitive plastic stocks consists of an extruder body with built-in heating means, a rotatably-mounted extrusion screw, a transverse cross-head secured to the delivery end of the extruder body, a die mounted in the cross-head, a stationary supporting sleeve, a frustro-conical rotary head mounted on the sleeve, and a shaping chamber mounted at the delivery end of the die. Plastic stock, which is subjected to scorching and heat-curing, can be advanced at a temperature sufficiently elevated to render it workable, but below its scorching point.

**Apparatus for Treating Polyethylene Bodies.** No. 2,746,084. Werner H. Kreidel, New York, N. Y. (to Traver Investments, Inc., Chicago, Ill.).

The apparatus renders polyethylene surfaces receptive to the transfer of decorative materials, and consists of the following parts: a suspension support for the material, a heater, a means for progressing the sheet material, and a mechanism for turning the heater about its axis.

**Apparatus for Applying a Plastic Coating to Threads, Yarns, Etc.** No. 2,736,289. Alfred W. Allen, Greensboro, N. C.

The thread-coating apparatus comprises the following elements arranged to form a recurrent circulation system for conducting a plastic mist; a tank, coating chamber, a mist-supplying conduit, an atomizing nozzle, a blower, and a return conduit.

**Process and Apparatus for Making Helical Coils from Thermoplastic Material.** No. 2,740,987. Leslie John Moncrieff, London, England. (to British Celanese, Ltd., Great Britain).

The apparatus comprises a mandrel rotatably mounted at one end, with sharply tapering end. A hollow member partially encloses the mandrel, and provides the outer wall of an annular space through which the helix passes. The mandrel and hollow member rotate at the same annular speed, and in the same direction.

**Removal of Molded Articles.** No. 2,744,286. James S. Carpenter, Chardon, John C. Shutt, Wickliffe, and John H. Winchester, Euclid, O. (to Eagle-Picher Co., Cincinnati, O.).

Semi-rigid molded articles can be removed from mold cavities with an apparatus which mechanically dislodges the article while simultaneously directing a jet of compressed air into the interstice, and subjecting the body to a suction pull. Parts include a portable suction head, a pry member, and an air jet nozzle.

**Molding Apparatus.** No. 2,744,288. Nathan Fienberg, Caulfield, Victoria, and Alan Reginald Calder, Newport, Victoria, Australia (to A. C. I. Plastics Proprietary, Ltd., Melbourne, Victoria, Australia).

The press for compression molding comprises a ring mold carrier supported for angular movement about a vertical axis; a plurality of alternative ring-shaped mold members with vertically-disposed axes; a means for intermittently actuating the mold carrier, whereby the mold members are successively moved to the mold station and stopped; a vertically-movable plunger, adapted to enter the mold member and seat against the inner surface; and a female form member. The mold member operates as a slideable piston to seal the cavity before the mold is fully closed. Action is automatic.

**Shell Molding Apparatus.** No. 2,741,005. Roschild Hurst, Detroit, Mich. (to Ford Motor Co., Dearborn, Mich.).

The machine has an invertible sand box closed on all but one side, a weight secured to the side opposite the open side, a screen parallel to the open side, and a pattern plate releasably closing the open side of the box.

## Processing

**Control of Temperature in Emulsion Polymerization.** No. 2,745,823. William C. Hewitt, Bartlesville, Okla. (to Phillips Petroleum Co., Bartlesville, Okla.).

The method of temperature control in the polymerization of a conjugated diene involves charging a stream of this monomeric material into a smooth-walled reaction zone, together with water, emulsifier, oxidant, and activator. A cooling medium is circulated in a number of separately-spaced elongated and confined paths bounded by walls of heat-transfer material. Stirring is required to prevent polymer particles from clinging to the cooling channels.

**Method of Manufacturing Thermoplastic Pellets.** No. 2,746,086. Herbert H. Vickers, Union, N. J. (to Esso Research & Engineering Co., New York, N. Y.).

A plurality of separate, heated thermoplastic rods are laid in the same plane and compressed to effect adhesion. After cooling, the rods are sliced transversely.

**Cellular Thermoplastic Bodies.** No. 2,746,088. Herbert Lindemann, Sins, Aargau, and Ernst Stirnemann, Basel, Switzerland.

Closed-cell thermoplastic articles with wrinkled cell walls are produced in two steps: the material is expanded through gas formation to form closed, gas-permeable, cellular material; and this material is subjected to partial vacuum below the temperature at which the material flows. This causes partial collapse of the cells, and results in a wrinkled appearance.

**Transfer Molding Method.** No. 2,738,551. Arthur M. Howald, Perrysburg, O. (to Glaskyd, Inc., Perrysburg, O.).

A quantity of filled, polyester molding compound and catalyst is placed in a receptacle with an orifice, and maintained at a temperature of 20-70° C. The orifice is brought into registry with the sprue hole of a mold which, in turn, is maintained at 130-200°C. The molding compound is forced into the mold under pressure, and cured.

**Method of Making Reinforced Laminated Material.** No. 2,742,391. Harold Warp, Chicago, Ill. (to Flex-O-Glass, Inc., a corporation of Illinois).

Reinforced laminates, consisting of a base and intermediate lamina of woven mesh are produced by passing the netting through a bath of synthetic organic polymer. This material is in solvent solution of such fluidity that only the filaments are coated. The solvent is driven off, leaving the polymer in its normal state. Solvent is then applied to one sheet, heat is applied to the other, and the sheets are pressed to opposite sides of the netting to form a bond.

**Method of Making an Expanded or Cellular PVC Composition.** No. 2,737,503. George R. Sprague, Shelton, and Frank M. Scantlebury, Jr., Woodbridge, Conn. (to B. F. Goodrich Co., Akron, O.).

Powdered PVC is mixed with a nitrogen-liberating blowing agent and a volatile plasticizer. This mixture is molded under heat and pressure, and cooled to produce the finished product.

**Process of Bonding a Metal Film to a Thermoplastic Sheet and Resulting Product.** No. 2,740,732. David B. Peck and Preston Robinson, Williamstown, Mass. (to Sprague Electric Co., North Adams, Mass.).

A metal vapor is condensed on the surface of a substantially-linear, thermoplastic, planar-oriented, dielectric polyester sheet, and heated to a temperature above its relaxation temperature. This disorients the surface, and results in a firm and uniform bonding of the metal.

**Process of Forming Adherent Polyethylene Coating on Metal Surfaces.** No. 2,737,461. Jerome S. Heisler, Albert Heisler, and Anthony J. Starr, Wilmington, Del.

To form polyethylene coatings on the inner surface of pails and the like, the containers are first heated to 350-475° F., and filled halfway with solid polyethylene particles. The container is then rotated in an inclined position to effect total contact, and the excess removed. Baking of the pail effects complete adhesion and fusion, giving an impermeable and insoluble lining.

**Extrusion Molding of Perfluorochlorocarbon Plastics.** No. 2,736,064. Louis C. Rubin, West Caldwell, N. J. (to M. W. Kellogg Co., Jersey City, N. J.).

The material is heated and moved through an extrusion chamber at a predetermined pressure, and at a temperature above its conversion point. The extruded material is passed through a second die which is provided with a cooling means to effect conversion.

**Method of Forming Hollow Articles from Polyethylene.** No. 2,736,925. Jerome S. Heisler, Albert Heisler, and Anthony J. Starr, Wilmington, Del.

The mold is heated to a temperature sufficient to cause incipient fusion of polyethylene, but below the thermal decomposition point. An excess of polyethylene powder is pressed onto the surface with a wiping action to produce a layer of partially-coalesced polyethylene particles, and the mold reheated to effect fusion. The lining is removed from the mold on cooling.

**Reinforced Plastic Articles.** No. 2,746,896. Henry C. Thompson, Houston, Tex. (to L-O-F Glass Fibers Co., Toledo, O.).

Highly-translucent reinforced plastic articles are produced by incorporating glass fibers coated with a chromium compound of the Werner type in a polyester resin. This resin should contain 2-30% by weight of alkyl esters of acrylic and methacrylic acid.

**Process for Flame Spraying Plastisol.** No. 2,746,883. John Bernard Powers, Metuchen, N. J. (to Union Carbide & Carbon Corp., New York, N. Y.).

A finely-atomized spray of plastisol is formed at a temperature below which appreciable solvation in the plasticizer occurs. This spray is then brought into contact with the hot combustion products of a gas flame, thereby causing partial solvation and gelling.

## Applications

**Cap for Plastic Extrusion Tube Container.** No. 2,732,870. Anthony Nichols, North Plainfield, N. J. (to Celluplastic Corp., Newark, N. J.).

The cap, adapted to stretch and thereby seal the tube mouth, comprises a thin-walled hollow stem of rigid plastic. The outside diameter of the top sealing portion is substantially greater than the inside diameter, which gives a tapering effect.

**Heat Resistant Polyamide Structure.** No. 2,733,162. William Earl Roseveare, Richmond, Va. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The polyamide structure has fine particles of magnesium, aluminum, strontium, or calcium imbedded in the surface.

**Method of Making Plastic Scintillation Phosphors.** No. 2,733,216. Geoffrey G. Eichholz and John L. Horwood, Ottawa, Ont. (to Canadian Minister of Mines and Technical Surveys).

Phosphor units for detecting and measuring radiation are produced by mixing polystyrene molding powder, 0.2-20% of a hydrocarbon fluorescence-producing material, and 0.002-0.05% of an agent which shifts the fluorescence spectrum into the visible region. The mixture is heated to a temperature of 85-105° C., under a pressure of 1,000-2,000 psi. to expel the air. Pressure is then raised to 4,000-20,000 psi., and the heat elevated to the melting point of the phosphor material. The mass can then be molded to the desired structural form.

**Plastic Irrigation Tubing Outlet.** No. 2,746,774. Hans L. Nielsen, Bakersfield, Calif.

The apparatus comprises an elongated tubular conduit formed from a flexible thermoplastic material, and having at least one opening extending transversely through the side wall. The opening has a substantially smaller diameter than the internal diameter of the conduit. The tubular outlet has a reversed end which forms a flange, and is fused to the conduit.

**Apparatus and Method for Making Folding Plastic Containers.** No. 2,746,360. Stanley Bright, Jr., Haverford, Pa. (to Troth Bright Page, Inc., Paoli, Pa.).

A seamless, plastic folding container blank is made from an extruded tube by flattening to form folded side edges, cutting a blank, and inserting a flat, rigid mandrel. Cutting is done along predetermined lines, the walls are scored, and a portion of each side edge is severed to form closing flaps at each end of the blank.

**Hand Swimming Paddle.** No. 2,745,119. Richard R. Whipple, Haverhill, Mass.

The paddle comprises a molded plastic body larger than the swimmer's hand. The solid outer surface contains a thumb indentation and accurately-disposed holes for the other fingers. The paddle itself has a cellular interior which causes it to float.

**Reinforced Plastic Pipe.** No. 2,742,931. Carl de Ganahl, Greenlawn, N. Y.

Glass reinforcing fibers are bonded by and imbedded in a monolithic, hollow plastic cylinder. A portion of the fibers are rovings, disposed helically in at least two cylindrical layers. Pitches of the helices are opposite in direction, but substantially equal in magnitude. The other fibers are arranged with random orientation in a substantially-felted mat.

**Plastic Desiccator.** No. 2,742,709. Charles M. De Woody, Vineland, N. J., and John J. Magera, Louisville, Ky. (to Ace Glass, Inc., Vineland, N. J.).

The desiccator comprises a substantially-hemispherical body of formed plastic, a floor plate, a convex plastic closure, complementary ceiling flanges, a supporting base, a means for connecting the closure to the source of vacuum, and a valve for controlling the vacuum.

**Flexible Floor Covering and Method of Making Same.** No. 2,742,377. Irving I. Bezman, Pittsburgh, Pa. (to Armstrong Cork Co., Lancaster, Pa.).

The floor covering consists of a saturated felt backing carrying a film deposited from an aqueous dispersion containing about 75-85% by weight filler, and 15-25% of a binder. This latter material contains 20-60% of a rosin compound, and 40-80% of a resinous styrene polymer. A fused top coat is deposited from an aqueous dispersion containing 25-35% filler and 65-75% of a binder, which is made up of 20-50% butadiene and 50-80% vinyl reinforcing resin.

# Current Market Prices

## Price Changes and Additions

### Adhesives

| | | | |
|---|---|---|---|
| Thixon CB | gal. | 3.30 / | 3.70 |
| CB-2 | gal. | 3.75 / | 3.95 |
| IB | gal. | 3.75 / | 4.15 |
| NB | gal. | 4.05 / | 4.45 |
| NM-2 | gal. | 7.20 / | 8.00 |

### Colors

| | | | |
|---|---|---|---|
| Eagle-Picher Basic carbonate White lead | lb. | .19 / | .20 |
| Basic silicate, white lead 201 | lb. | .2075/ | .2175 |
| 202 | lb. | .20 / | .21 |
| Litharge | lb. | .19 | |
| Sublimed | lb. | .1910 | |

### Plasticizers

| | | | |
|---|---|---|---|
| Drew DP-100, DP-200 | lb. | .425 / | .46 |
| DP-250 | lb. | .435 / | .47 |
| DP-316 | lb. | .30 / | .335 |
| DP-317 | lb. | .5625/ | .5975 |
| DP-520 | lb. | .4225/ | .4575 |
| SC | lb. | .44 | |
| Polycizer 162 | lb. | .28 / | .29 |
| 332, 532, 632 | lb. | .40 / | .43 |
| 562 | lb. | .305 / | .335 |
| 662 | lb. | .29 / | .445 |

### Resins & Molding Compounds

**Epoxy**

| | | | |
|---|---|---|---|
| Maraset 607, 610, 614, 616 | lb. | .65 / | 1.55 |

**Polyamide**

| | | | |
|---|---|---|---|
| Nylatron G, GS | lb. | 1.75 / | 2.00 |

*News of the Industry*

(*Cont'd. from page 604*)

## In Brief . . .

**The Society of the Plastics Industry, Inc.,** New York, N. Y., has announced the availability of a color slide film entitled "Quality Plastic Wall Tile—Plus Value for Today's Home." The film will be shown to industry and consumer groups as a selling tool to help builders.

**Eastman Chemical Products, Inc.,** Kingsport, Tenn., has announced the availability of Tenite butyrate in nine standard colors for outdoor signs. Specially formulated to withstand fading and weathering, the colors include two reds, two blues, two greens, a yellow, white, and ivory.

**Celanese Corp. of America** has moved its European office from Dusseldorf, Germany to 17 Rue Nueve du Molard, Geneva, Switzerland. R. J. Davis continues to direct the operation.

**Dow Chemical Co.'s** New Orleans sales office has occupied new quarters at 305 Maritime Bldg. The new office provides the additional space required to handle an increasing volume of business in the New Orleans territory. It services markets for chemicals, plastics, and magnesium in Louisiana, northwestern Florida, southwestern Alabama, and the southern half of Mississippi.

**Dow Chemical Co.,** Midland, Mich., has announced the availability of a 20-minute, 16mm color film covering the use of Styrofoam as insulation in masonry-constructed homes.

**Avisco Film Corp.,** a wholly-owned subsidiary of American Viscose Corp.'s film division, has opened a new office-warehouse in Atlanta, Ga. Located at 190 Ottley Drive, N. E., the facility covers 36,000 square feet.

**Cadillac Plastic & Chemical Co.,** Detroit, Mich., has opened a branch office in Milwaukee, Wisc., at 517 N. Broadway, as another step in its expansion program. Two more branch offices are scheduled to be opened this fall in Midwest cities.

**Borden Co.'s chemical division,** New York, N. Y., has increased prices of its powdered shell molding resins for the foundry by 1½¢ per pound, effective July 1. The new prices are 26¢ per pound in truckload quantities, and 27¢ per pound in smaller quantities.

**E. I. du Pont de Nemours & Co.'s** film department, Wilmington, Del., is making its Cel-O-Seal cellulose bands in larger sizes. Bands now can be produced in diameters up to and including 4.02 inches (102 millimeters). The production change was necessitated by demand for larger sizes in the food and drug trade, and increasing use of the bands to couple units for sampling or multiple packaging purposes.

**E. I. du Pont de Nemours & Co.,** Wilmington, Del., will double its production of Teflon 6 tetrafluoroethylene resin, a fine powder composition developed for extrusion. The material was first produced in commercial quantities last fall, and is used for making electrical insulation hose and tapes, and for insulating wire and cable.

**Goodyear Tire & Rubber Co.,** Akron, O., has appointed four additional distributors for its line of rubber and vinyl flooring: H & H Distributors, Inc., 2215 Central Ave., Memphis, Tenn.; Southern Flooring Co., 101 Third Ave., Albany, Ga., Yellowstone Paper Co., 504 North 20th St., Billings, Mont., and Tiffany Tile Corp., 1963 Fourth Ave., St. Petersburg, Fla.

**Phillips Petroleum Co.,** Bartlesville, Okla., has licensed Société Solvay et Cie, a Brussels, Belgium, firm with operating offices in Italy, to use the Phillips process for making rigid polyethylene. The agreement gives Solvay et Cie exclusive rights in Italy to Phillips' patents and technical information on the plastic.

**Rodney Hunt Machine Co.,** Orange, Mass., has appointed E. M. Underwood & Co., of Los Angeles and San Francisco, Calif., as manufacturer's agent for Turba-Film Evaporators and other Rodney Hunt process equipment in California and Nevada.

**Quality Tolls Corp.,** 108 Nassau Road, Roosevelt, L. I., N. Y., has been formed to manufacture models and molds for use in vacuum forming of plastic sheet materials. Sanford S. Zimmerman will serve as president.

**General Tire & Rubber Co.'s Jeannette division,** Jeannette, Pa., has announced the availability of three new Boltaflex patterns: Flaxen Wisp, Cortina, and Mantilla. These unsupported vinyl materials are marketed in 0.012-gage, 54-inch rolls.

**Carbide & Carbon Chemicals Co.** has moved its New York district sales office to 100 East 42nd St., New York, N. Y.

(*Continued on page 626*)

# Domestic Production and Sales of Plastics and Resin Material, April and May, 1956

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of April and May, 1956. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Over six-million more pounds of plastics were produced during May, though sales remained virtually the same. Largest gains percentage-wise were in the categories of polyethylene and polyesters.

| | April | | May | |
|---|---|---|---|---|
| | Production | Sales | Production | Sales |
| Cellulose Plastics:[1] | | | | |
| Cellulose acetate and mixed ester: | | | | |
| Sheets, under 0.003 gage | 1,544,763 | 1,659,595 | 1,465,760 | 1,529,991 |
| Sheets, 0.003 gage and over | 1,398,121 | 1,264,825 | 1,345,982 | 1,347,293 |
| All other sheets, rods, and tubes | 663,561 | 625,461 | 668,924 | 613,164 |
| Molding and extrusion materials | 7,376,371 | 7,076,539 | 7,414,793 | 7,336,497 |
| Nitrocellulose sheets, rods, and tubes | 512,854 | 470,667 | 568,623 | 412,757 |
| Other cellulose plastics | 429,114 | 356,405 | 489,098 | 483,379 |
| TOTAL | 11,924,784 | 11,453,492 | 11,953,180 | 11,723,081 |
| Phenolic and Other Tar-Acid Resins: | | | | |
| Molding materials[1] | 20,609,235 | 17,616,322 | 20,488,967 | 17,642,526 |
| Bonding and adhesive resins for— | | | | |
| Laminating (except plywood) | 5,070,957 | 3,458,330 | 5,403,363 | 3,311,869 |
| Coated and bonded abrasives | 1,509,268 | 1,547,011 | 1,251,248 | 1,257,569 |
| Friction materials (brake linings, clutch facings, and similar materials) | 1,663,360 | 1,644,050 | 1,283,489 | 1,003,110 |
| Thermal insulation (fiber glass, rock wool) | 4,742,959 | 4,478,868 | 4,461,901 | 5,287,201 |
| Plywood | 3,746,510 | 2,932,613 | 3,424,757 | 2,685,992 |
| All other bonding and adhesive uses | 2,835,023 | 2,957,337 | 2,769,800 | 2,712,798 |
| Protective-coating resins, unmodified and modified except by rosin | 2,673,802 | 2,198,841 | 2,733,826 | 2,076,202 |
| Resins for all other uses | 2,629,433 | 2,073,524 | 2,590,146 | 2,377,772 |
| TOTAL | 45,480,547 | 38,906,896 | 44,407,497 | 38,355,039 |
| Urea and Melamine Resins: | | | | |
| Textile-treating and textile-coating resins | 3,887,267 | 2,742,259 | 3,404,936 | 3,256,302 |
| Paper-treating and paper-coating resins | 2,321,262 | 2,093,767 | 2,177,360 | 2,315,576 |
| Bonding and adhesive resins for— | | | | |
| Plywood | 8,169,467 | 8,363,919 | 8,276,698 | 7,598,178 |
| All other bonding and adhesive uses, including laminating | 1,877,546 | 1,666,375 | 1,954,232 | 2,153,825 |
| Protective-coating resins, straight and modified | 3,708,570 | 2,534,698 | 3,116,154 | 2,184,278 |
| Resins for all other uses, including molding | 7,104,102 | 5,778,909 | 7,642,109 | 7,480,905 |
| TOTAL | 27,068,214 | 23,179,927 | 26,571,489 | 24,989,064 |
| Styrene Resins: | | | | |
| Molding materials[1] | 40,172,330 | 40,585,443 | 40,798,205 | 37,669,943 |
| Protective-coating resins, straight and modified | 7,698,851 | 7,780,713 | 8,026,653 | 8,447,944 |
| Resins for all other uses | 8,639,466 | 9,170,161 | 9,293,547 | 8,189,503 |
| TOTAL | 56,510,647 | 57,536,317 | 58,118,405 | 54,307,390 |
| Vinyl and Vinyl Chloride Resins:[2] | | | | |
| Polyvinyl chloride and copolymer resins (50% or more PVC) for— | | | | |
| Film (resin content) | | 6,247,472 | | 5,948,168 |
| Sheeting (resin content) | | 4,674,168 | | 4,403,274 |
| Molding and extrusion (resin content) | | 15,560,437 | | 16,469,944 |
| Textile and paper treating and coating (resin content)[3] | | 4,646,341 | | 4,321,583 |
| Flooring (resin content) | | 4,493,648 | | 5,074,998 |
| Protective coatings (resin content) | | 2,343,848 | | 2,458,334 |
| All other uses (resin content) | | 7,294,885 | | 6,087,030 |
| All other vinyl resins for— | | | | |
| Adhesives (resin content) | | 3,113,594 | | 3,287,569 |
| All other uses (resin content) | | 11,611,810 | | 10,157,634 |
| TOTAL | 65,487,045 | 59,986,203 | 63,977,448 | 58,208,534 |
| Coumarone-Indene and Petroleum Polymer Resins | 20,343,944 | 20,169,912 | 20,966,161 | 20,237,699 |
| Polyester Resins | 5,854,567 | 5,777,502 | 7,288,892 | 6,886,731 |
| Polyethylene Resins | 42,205,117 | 38,782,883 | 46,710,189 | 41,549,347 |
| Miscellaneous Synthetic Plastics and Resin Materials: | | | | |
| Molding materials[1,4] | 3,371,774 | 2,822,310 | 3,706,407 | 3,100,052 |
| Protective-coating resins[5] | 697,171 | 388,691 | 1,142,783 | 502,393 |
| Resins for all other uses[6] | 10,530,440 | 9,482,373 | 10,802,776 | 9,530,533 |
| TOTAL | 14,599,385 | 12,693,374 | 15,651,966 | 13,132,978 |
| GRAND TOTALS | 289,474,250 | 268,486,506 | 295,645,227 | 269,389,863 |

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
SOURCE: United States Tariff Commission, Chemical Division.

## CALENDAR of COMING EVENTS

**September 16-21**
American Chemical Society's 130th National Meeting. Atlantic City, N. J.

**September 17-21**
Second Pacific Area National Meeting, American Society for Testing Materials. Hotel Statler, Los Angeles, Calif.

**September 19**
SPE New York Section. Gotham Hotel, New York, N. Y.

**September 20**
SPE Regional Technical conference. Sheraton-Mount Royal Hotel, Montreal, Que.

**September 26**
Reinforced Plastics Group, SPE New York Section. Tufaro's Restaurant, Corona (Queens), N. Y.

**October 3**
SPE Western New England Section. Bradley Field, Windsor Locks, Conn.

**October 4**
SPE Southern California Section. Scully's Restaurant, Los Angeles, Calif.

**October 8**
SPE Cleveland-Akron Section. Spanish Tavern, Brecksville, Ohio

**October 10**
SPE Newark Section. Military Park Hotel, Newark, N. J.

**October 11-12**
SPI New England Section Conference. Wentworth Hotel, Portsmouth, N. H.

**October 15**
SPE Detroit Section. Rackham Memorial Bldg., Detroit, Mich.

SPE Southern Section. Mammy's Shanty, Atlanta, Ga.

**October 15-17**
ASTM Committee D-20 on Plastics. Chase Park Hotel, St. Louis, Mo.

**October 16**
SPE St. Louis Section. Melbourne Hotel, St. Louis, Mo.

**October 17**
SPE Chicago Section. Western Society of Engineers Bldg., Chicago, Ill.

SPE New York Section. Gotham Hotel, New York, N. Y.

**October 18**
SPE Eastern New England Section. Hotel Beaconsfield, Brookline, Mass.

SPE Ontario Section. St. Regis Hotel, Toronto.

**October 24**
SPE Philadelphia Section. Franklin Institute, Philadelphia, Pa.

Reinforced Plastics Group, SPE New York Section. Tufaro's Restaurant, Corona (Queens), N. Y.

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**The Achema 1958** is to take place May 31-June 8, 1958, in Frankfurt, Germany. Preliminary applications have already made it clear that present facilities will be inadequate, and the city of Frankfurt will build an additional, modern hall with an area of about 8,000 square meters. New lecture rooms, cinemas, and accommodations for visitors also are planned.

**Rubber Improvements, Ltd.,** Wellingborough, Northants, England, has received a substantial order for PVC belting from the U.S.S.R. This order, believed to be the first of its type, is apparently for an establishment near Moscow.

**NRC Equipment Corp.,** a subsidiary of National Research Corp., Newton Highlands, Mass., has appointed two new representatives for its high-vacuum equipment. W. C. Davis & Associates, Atlanta, Ga., will represent NRC interests in the Southeast, and Winnett Boyd, Ltd., Toronto, Ont., will act as exclusive agents in the provinces of Ontario and Quebec.


## *Positions Open*

Classified Rates $5.00 per Inch.

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**VINYL PLASTICIZERS SALES**

Our Plasticizer Division is expanding rapidly with new products and applications. An opening exists for a technical salesman to work out of our New York office. Territory will comprise part of New Jersey and metropolitan area. Applicant should have at least two years selling experience in the vinyl industry on plasticizers or allied raw materials. Should have working knowledge of calendering, extrusion, molding and plastisol formulation. Age 25-35. Salary open. Send resume to:

Personnel Director
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700 Investors Bldg.
Minneapolis, Minnesota

CHEMIST familiar with methyl methacrylate, n-butyl methacrylate, and acrylics of high ester who can supply formula for (soft) denture liner. Write, Vern Baker, Elyria, Ohio